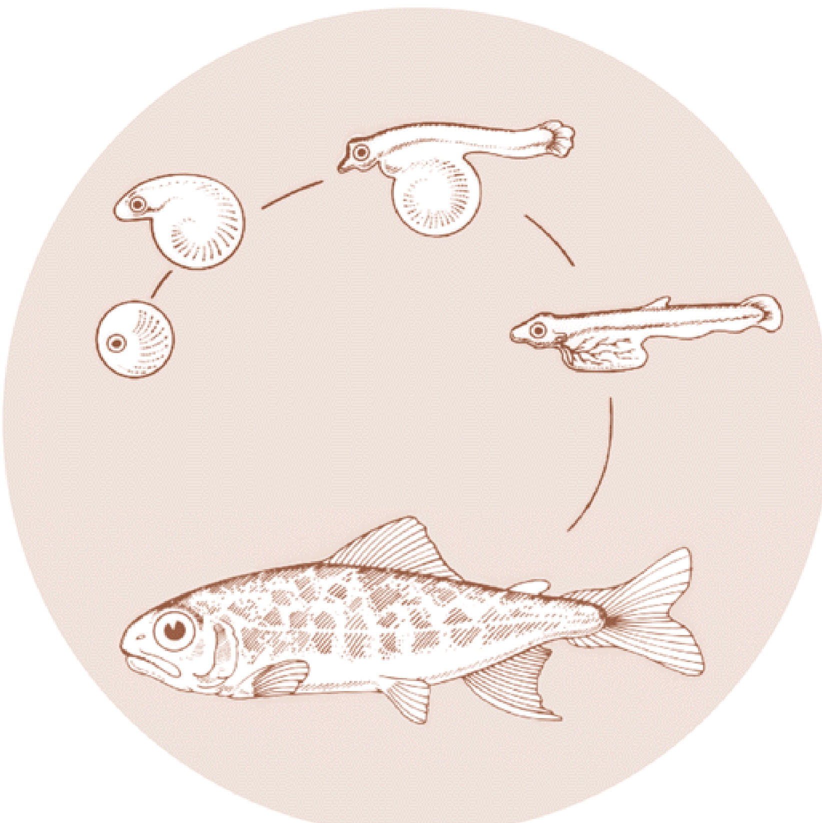
March 1995

NORTHEAST OREGON HATCHERY PROJECT CONCEPTUAL DESIGN REPORT

Final Report



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NORTHEAST OREGON HATCHERY PROJECT

CONCEPTUAL DESIGN REPORT

FINAL REPORT

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Project Number 88-53
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March 1995

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ACKNOWLEDGMENTS

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Funding for the project was provided by the Bonneville Power Administration under Contract No. DE-AC79-91BP11466.

EXECUTIVE SUMMARY

This report presents the results of site analysis for the Bonneville Power Administration Northeast Oregon Hatchery Project. The purpose of this project is to provide engineering services for the siting and conceptual design of hatchery facilities for the Bonneville Power Administration. The hatchery project consists of artificial production facilities for salmon and steelhead to enhance production in three adjacent tributaries to the Columbia River in northeast Oregon: the Grande Ronde, Walla Walla, and Imnaha River drainage basins. Facilities identified in the master plan include adult capture and holding facilities: spawning incubation, and early rearing facilities; full-term rearing facilities; and direct release or acclimation facilities. The evaluation includes consideration of a main production facility for one or more of the basins or several smaller satellite production facilities to be located within major subbasins.

The historic and current distribution of spring and fall chinook salmon and steelhead was summarized for the Columbia River tributaries. Current and future production and release objectives were reviewed. Among the three tributaries, forty seven sites were evaluated and compared to facility requirements for water and space. Site screening was conducted to identify the sites with the most potential for facility development. Alternative sites were selected for conceptual design of each facility type. A proposed program for adult holding facilities, final rearing/acclimation, and direct release facilities was developed

INTRODUCTION

PROJECT BACKGROUND

This report presents the results of work carried out under Task 3, Conceptual Design, of the contract between Bonneville Power Administration (BPA) and Montgomery Watson for the Northeast Oregon Hatchery Project (NEOH).

The purpose of this project is to evaluate site locations and provide conceptual design for fish production facilities designed to enhance and/or reestablish salmon stocks in the Walla Walla, Grande Ronde, and Imnaha basins of the NEOH planning area and meet the production goals identified in the basin master plans. Basin master planning for NEOH project production goals has been carried out previously by affected tribes, state resource agencies, and the federal government.

Salmonid stocks under consideration include spring and fall chinook salmon and steelhead. Facilities required include adult capture and holding facilities; spawning, incubation, and early rearing facilities; full-term rearing facilities; and direct release or acclimation facilities. The evaluation includes consideration of a main production facility for one or more of the basins or several smaller satellite production facilities to be located within major subbasins.

The technical basis for most of preliminary design in this report was developed during preparation of the NEOH Siting Report (contract Tasks 1 and 2). Technical oversight for the NEOH project is carried out by BPA and the NEOH Technical Work Group (TWG), which is comprised of BPA, Oregon Department of Fish and Wildlife (ODF&W), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Nez Perce Tribe (NPT). Technical information was presented in a number of working papers which were subsequently reviewed and discussed by the TWG, then revised as necessary by Montgomery Watson.

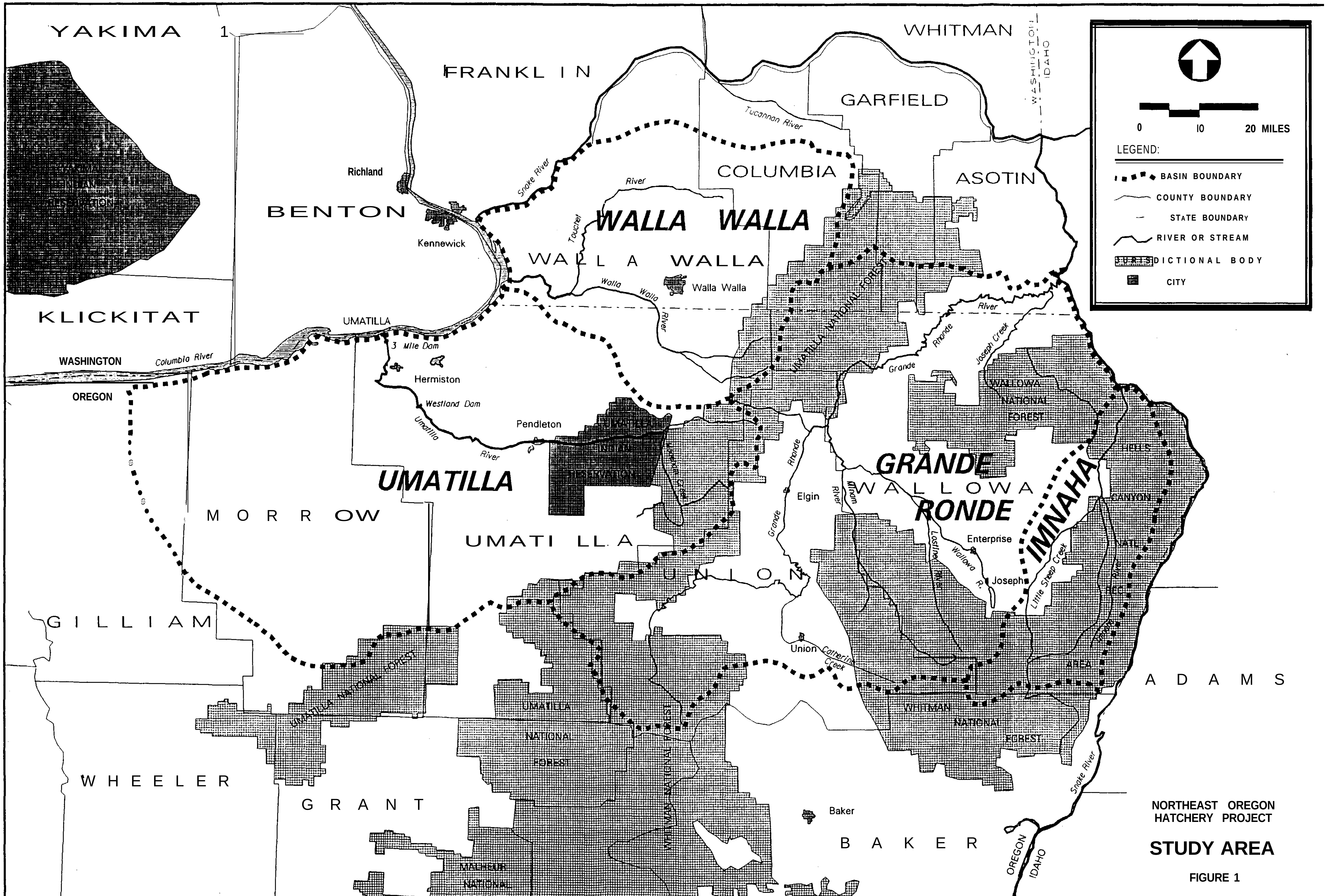
STUDY AREA

The project study area includes three adjacent river basins tributary to the Columbia River: the Grande Ronde, Walla WaIla, and Imnaha River drainage basins in northeastern Oregon (Figure 1).

The Walla Walla River discharges directly to the Columbia River in Washington state near the Oregon - Washington border. Within the Walla Walla drainage basin, the South Fork Walla Walla River and the Touchet River drainage basins contain most of the planned NEOH facilities. A portion of the production facilities planned for the Walla Walla basin are designated to meet production goals in the adjacent Umatilla River basin.

The Grande Ronde River discharges to the Snake River at approximately River Mile 169 near Rogersburg, WA along the Washington - Idaho border. Within the Grande Ronde drainage basin, subdivisions into the Upper Grande Ronde, Catherine Creek, Lower Grande Ronde, and Wallowa-Lostine subbasins were made for NEOH facility planning.

The Imnaha River discharges to the Snake River upstream of the Grande Ronde at approximately River Mile 192 along the Oregon - Idaho border. The Imnaha River is considered as a single basin for NEOH facility planning.



NORTHEAST OREGON HATCHERY PROJECT

STUDY AREA

FIGURE 1

TERMINOLOGY

Numerous fish culture terms with very specific meanings are used in the planning and design of NEOH project facilities. Table 1 presents a listing of these terms and a definition of their meaning in the NEOH project.

TABLE 1

DEFINITION OF NEOH FISH CULTURE TERMS

Term	Process Endpoints	Other Terms/Comments
ADULT Holding	Capture to maturation	
Spawning & Fertilization	Gametes to fertilized gametes	
Incubation	Fertilized gametes to swim-up and first feeding	
Rearing		
Early Rearing	First feeding to 200/LB	
Full-Term Rearing	2OO/lb to final transport size (or release if direct release from a full-term rearing site). Full-term rearing may occur at a hatchery or a satellite rearing facility.	also called Satellite Rearing
Timed Release Fed Fry	Rearing of spring chinook from 2OO/lb to 15O/lb with outplanting during March to April of their first year. Release would be into a natural, or engineered, flowing pool situation. Assumed that full term rearing would occur within river system	

TABLE 1 (continued)

Release Methods		
Final Rearing & Release	Transport of fingerlings from a full-term rearing facility to a final rearing and release site for a 3-30 day acclimation period. The fish may be fed, but no significant growth will occur during this phase.	Also called Acclimation/Extended Rearing
Direct Release	Transport of fingerlings from a full-term rearing facility to a direct release site. The fish will be discharged directly from the transport truck into the river.	
Hatchery	Has the following fish culture elements: Adult holding Spawning Incubation Early rearing Full-term rearing	
Satellite Facility	Has the following fish culture elements: Adult holding Spawning May also include: Full-term rearing	

The process criteria defined in the following sections refer to these terms and their process endpoints.

FISH PROPAGATION CRITERIA

INTRODUCTION

The biocriteria proposed for the NEOH Project are based on similar salmon culture projects in the Pacific Northwest and discussion with agency and tribal personnel. These criteria will be used for planning level process design and facility layout.

WATER CHEMISTRY

Fundamental to facility planning is an understanding of various aspects of water chemistry, in both a general and site-specific sense.

Oxygen

The oxygen content of water used in fish rearing is important because the fish will consume varying amounts of oxygen as they develop and also, a certain minimum concentration of dissolved oxygen is required in order to provide an acceptable environment. For these reasons it is desirable to know the approximate dissolved oxygen concentration of the water supply and how it may vary with the degree of gas saturation, temperature, salinity, and site elevation.

The maximum amount of oxygen that can be dissolved in water is referred to as the saturation concentration. The saturation concentration depends on temperature, elevation (or barometric pressure), and salinity. Increasing temperature decreases the saturation concentration of oxygen (Table 2). Salinity (total dissolved solids) will have an insignificant effect on oxygen solubility at the NEOH sites.

Ammonia

Ammonia is produced by fish as a metabolic byproduct. In addition, water supplies often contain ammonia from pollution or natural sources. Fish have a limited tolerance to ammonia under certain conditions. Ammonia is a weak base, and occurs as ionized (NH_4^+) and un-ionized forms (NH_3). Un-ionized ammonia moves easily across biological membranes and is generally considered the most toxic of the two forms. The concentration of un-ionized ammonia in freshwater is primarily a function of pH and temperature (Table 3).

Carbon Dioxide

Fish have limited tolerance to carbon dioxide. Carbon dioxide is produced by fish as a respiratory byproduct, and water supplies often contain high concentrations of carbon dioxide. Under typical conditions, 1.375 mg of carbon dioxide is produced per 1 mg of oxygen consumed. The excretion of carbon dioxide by fish in intensive culture situations (a) increases the dissolved carbon dioxide concentration, (b) reduces the pH, and (c) reduces the concentration of un-ionized ammonia due to the decrease in pH. The reduction

TABLE 2

DISSOLVED OXYGEN AS A FUNCTION OF TEMPERATURE (2,000 FEET ELEVATION)

	DT@')									
Temp (F)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
32	13.61	13.59	13.57	13.55	13.53	13.51	13.49	13.46	13.44	13.42
33	13.40	13.38	13.36	13.34	13.32	13.30	13.28	13.26	13.24	13.22
34	13.20	13.17	13.15	13.13	13.11	13.09	13.07	13.05	13.03	13.01
35	12.99	12.97	12.95	12.93	12.91	12.90	12.88	12.86	12.84	12.82
36	12.80	12.78	12.76	12.74	12.72	12.70	12.68	12.66	12.64	12.63
37	12.61	12.59	12.57	12.55	12.53	12.51	12.49	12.48	12.46	12.44
38	12.42	12.40	12.38	12.37	12.35	12.33	12.31	12.29	12.27	12.26
39	12.24	12.22	12.20	12.18	12.17	12.15	12.13	12.11	12.10	12.08
40	12.06	12.04	12.03	12.01	11.99	11.97	11.96	11.94	11.92	11.91
41	11.89	11.87	11.85	11.84	11.82	11.80	11.79	11.77	11.75	11.74
42	11.72	11.70	11.69	11.67	11.65	11.64	11.62	11.60	11.59	11.57
43	11.55	11.54	11.52	11.51	11.49	11.47	11.46	11.44	11.43	11.41
44	11.39	11.38	11.36	11.35	11.33	11.31	11.30	11.28	11.27	11.25
45	11.24	11.22	11.21	11.19	11.17	11.16	11.14	11.13	11.11	11.10
46	11.08	11.07	11.05	11.04	11.02	11.01	10.99	10.98	10.96	10.95
47	10.93	10.92	10.90	10.89	10.87	10.86	10.85	10.83	10.82	10.80
48	10.79	10.77	10.76	10.74	10.73	10.72	10.70	10.69	10.67	10.66
49	10.64	10.63	10.62	10.60	10.59	10.57	10.56	10.55	10.53	10.52
50	10.50	10.49	10.48	10.46	10.45	10.44	10.42	10.41	10.40	10.38
51	10.37	10.35	10.34	10.33	10.31	10.30	10.29	10.27	10.26	10.25
52	10.24	10.22	10.21	10.20	10.18	10.17	10.16	10.14	10.13	10.12
53	10.10	10.09	10.08	10.07	10.05	10.04	10.03	10.02	10.00	9.99
54	9.98	9.96	9.95	9.94	9.93	9.91	9.90	9.89	9.88	9.87
55	9.85	9.84	9.83	9.82	9.80	9.79	9.78	9.77	9.76	9.74
56	9.73	9.72	9.71	9.69	9.68	9.67	9.66	9.65	9.64	9.62
57	9.61	9.60	9.59	9.58	9.56	9.55	9.54	9.53	9.52	9.51
58	9.50	9.48	9.47	9.46	9.45	9.44	9.43	9.41	9.40	9.39
59	9.38	9.37	9.36	9.35	9.34	9.32	9.31	9.30	9.29	9.28
60	9.27	9.26	9.25	9.24	9.23	9.21	9.20	9.19	9.18	9.17
61	9.16	9.15	9.14	9.13	9.12	9.11	9.10	9.08	9.07	9.06
62	9.05	9.04	9.03	9.02	9.01	9.00	8.99	8.98	8.97	8.96
63	8.95	8.94	8.93	8.92	8.91	8.90	8.89	8.88	8.87	8.86
64	8.85	8.83	8.82	8.81	8.80	8.79	8.78	8.77	8.76	8.75
65	8.74	8.73	8.72	8.71	8.70	8.69	8.69	8.68	8.67	8.66
66	8.65	8.64	8.63	8.62	8.61	8.60	8.59	8.58	8.57	8.56
67	8.55	8.54	8.53	8.52	8.51	8.50	8.49	8.48	8.47	8.46
68	8.45	8.45	8.44	8.43	8.42	8.41	8.40	8.39	8.38	8.37
69	8.36	8.35	8.34	8.33	8.32	8.32	8.31	8.30	8.29	8.28
70	8.27	8.26	8.25	8.24	8.23	8.23	8.22	8.21	8.20	8.19

TABLE 3

UN-IONIZED AMMONIA AS A PERCENTAGE OF TOTAL AMMONIA IN FRESHWATER AT VARIOUS TEMPERATURES AND PH

	pH												
Temp(F)	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8	8.1
32	0.066	0.083	0.104	0.131	0.165	0.207	0.261	0.328	0.413	0.519	0.653	0.820	1.030
33	0.069	0.087	0.109	0.137	0.173	0.217	0.273	0.344	0.432	0.544	0.683	0.859	1.079
34	0.072	0.091	0.114	0.144	0.181	0.227	0.286	0.360	0.453	0.569	0.716	0.899	1.130
35	0.075	0.095	0.120	0.150	0.189	0.238	0.300	0.377	0.474	0.596	0.749	0.942	1.183
36	0.079	0.099	0.125	0.158	0.198	0.249	0.314	0.395	0.496	0.624	0.785	0.986	1.238
37	0.083	0.104	0.131	0.165	0.208	0.261	0.329	0.413	0.520	0.653	0.821	1.032	1.295
38	0.087	0.109	0.137	0.173	0.217	0.273	0.344	0.433	0.544	0.684	0.859	1.079	1.355
39	0.091	0.114	0.144	0.181	0.227	0.286	0.360	0.453	0.569	0.715	0.899	1.129	1.417
40	0.095	0.119	0.150	0.189	0.238	0.299	0.376	0.474	0.595	0.748	0.940	1.181	1.482
41	0.099	0.125	0.157	0.198	0.249	0.313	0.394	0.495	0.623	0.783	0.983	1.235	1.550
42	0.104	0.131	0.164	0.207	0.260	0.327	0.412	0.518	0.651	0.818	1.028	1.291	1.620
43	0.109	0.137	0.172	0.216	0.272	0.342	0.431	0.542	0.681	0.856	1.075	1.349	1.693
44	0.113	0.143	0.180	0.226	0.285	0.358	0.450	0.566	0.712	0.894	1.123	1.410	1.769
45	0.119	0.149	0.188	0.236	0.298	0.374	0.471	0.592	0.744	0.935	1.174	1.473	1.848
46	0.124	0.156	0.196	0.247	0.311	0.391	0.492	0.618	0.777	0.977	1.227	1.539	1.930
47	0.130	0.163	0.205	0.258	0.325	0.409	0.514	0.646	0.812	1.020	1.281	1.608	2.015
48	0.135	0.170	0.214	0.270	0.339	0.427	0.537	0.675	0.848	1.066	1.338	1.679	2.104
49	0.141	0.178	0.224	0.282	0.355	0.446	0.561	0.705	0.886	1.113	1.397	1.752	2.196
50	0.148	0.186	0.234	0.294	0.370	0.466	0.586	0.736	0.925	1.162	1.458	1.829	2.292
51	0.154	0.194	0.244	0.307	0.387	0.486	0.612	0.769	0.966	1.213	1.522	1.909	2.391
52	0.161	0.203	0.255	0.321	0.404	0.508	0.639	0.802	1.008	1.266	1.589	1.992	2.494
53	0.168	0.212	0.266	0.335	0.422	0.530	0.666	0.838	1.052	1.321	1.657	2.078	2.601
54	0.176	0.221	0.278	0.350	0.440	0.553	0.695	0.874	1.098	1.378	1.729	2.167	2.713
55	0.183	0.231	0.290	0.365	0.459	0.577	0.726	0.912	1.145	1.438	1.803	2.259	2.828
56	0.191	0.241	0.303	0.381	0.479	0.602	0.757	0.951	1.195	1.499	1.880	2.355	2.947
57	0.200	0.251	0.316	0.397	0.500	0.628	0.790	0.992	1.246	1.563	1.960	2.455	3.071
58	0.208	0.262	0.329	0.414	0.521	0.655	0.823	1.034	1.299	1.630	2.043	2.558	3.200
59	0.217	0.273	0.344	0.432	0.543	0.683	0.859	1.078	1.354	1.699	2.129	2.665	3.333
60	0.226	0.285	0.358	0.451	0.567	0.712	0.895	1.124	1.411	1.770	2.218	2.777	3.471
61	0.236	0.297	0.373	0.470	0.591	0.742	0.933	1.172	1.470	1.844	2.311	2.892	3.613
62	0.246	0.309	0.389	0.490	0.616	0.774	0.972	1.221	1.532	1.921	2.407	3.011	3.761
63	0.256	0.323	0.406	0.510	0.641	0.806	1.013	1.272	1.596	2.001	2.506	3.134	3.914
64	0.267	0.336	0.423	0.532	0.668	0.840	1.055	1.325	1.662	2.083	2.609	3.262	4.073
65	0.278	0.350	0.440	0.554	0.696	0.875	1.099	1.380	1.731	2.169	2.716	3.395	4.237
66	0.290	0.365	0.459	0.577	0.725	0.911	1.145	1.437	1.802	2.258	2.826	3.532	4.406
67	0.302	0.380	0.478	0.601	0.755	0.949	1.192	1.496	1.876	2.350	2.940	3.674	4.581
68	0.315	0.396	0.498	0.626	0.786	0.988	1.241	1.557	1.952	2.445	3.059	3.821	4.763
69	0.328	0.412	0.518	0.651	0.819	1.028	1.291	1.620	2.031	2.544	3.181	3.972	4.950
70	0.341	0.429	0.539	0.678	0.852	1.070	1.344	1.686	2.113	2.646	3.308	4.129	5.144

of pH depends on the initial carbon dioxide concentration, alkalinity of the water, and amount of carbon dioxide produced.

PH

pH has a major role in determining the toxicity of ammonia, heavy metals, and hydrogen sulfide. The pH of the process water can be changed due to the metabolic activity of the fish and biological filters.

Temperature

Temperature has a major impact on the rate of development of eggs, fry, and fingerlings. Heating and chilling can be used to adjust the development rate of a given life stage. Temperature adjustment for eggs and small fry is less expensive as less water is needed for these life stages. High temperatures can also increase disease and mortality. This is especially critical for the holding of adult spring chinook because of the length of holding and ambient water temperatures in Northeast Oregon. In many of the smaller streams, die1 temperature changes of 10-15 F may occur, especially when the riparian vegetation has been removed.

WATER QUALITY CRITERIA FOR SALMONID REARING

Water quality criteria that provide general guidance in salmonid aquaculture planning are shown on Table 4.

Minimum Oxygen Levels

The minimum criterion for acceptable dissolved oxygen levels for salmonid culture (as the water leaves the raceways) is:

Fry & Fingerlings	**7.0** mg/l

As the incubation temperature increases, dissolved oxygen problems may occur just prior to hatching when dissolved oxygen demand is highest. The critical dissolved oxygen level may be above the local saturation concentration at those times.

Ammonia Criteria

Ammonia is a weak base and exists in ionized (NH_4^+) and un-ionized (NH_3) form. Un-ionized ammonia is more toxic to fish because it can move across biological membranes much faster than the ionized form. Chemical tests measure the amount of total ammonia ($NH_4^+ + NH_3$) which is generally expressed as nitrogen (molecular weight = 14.00 g/mol). The concentration of un-ionized ammonia depends on total ammonia, pH, and temperature. High pH and temperature favor the un-ionized form. Various criteria for the maximum allowable un-ionized ammonia concentration for salmonids range from 0.006 to 0.015 mg/L as NH_3-N (Table 4). A recent review of ammonia toxicity (Meade, 1985) concluded that un-ionized ammonia is probably not the cause of gill hyperplasia, as previously assumed. He also stated that "A truly safe, maximum acceptable concentration of un-ionized, or total ammonia for fish culture systems is not known". For this project, unionized ammonia criteria will be set at a concentration not to exceed 0.015 mg/l.

Carbon Dioxide

To determine carbon dioxide water quality criteria, it is also necessary to define critical levels. Recently, Piper et al. (1982) proposed an upper limit concentration of 10 mg/l, although others have suggested up to 20 mg/l (SECL, 1983). For NEOH planning 10 mg/l will be used as the carbon dioxide criterion. The carbon dioxide criteria may also depend on the relationship between carbon dioxide, alkalinity, and pH.

PH

Criteria for pH depend on species, life stage, and ionic composition of the water. For incubation and early fry rearing, SECL (1983) recommended that the pH be maintained between 6.5 - 8.5. This range will be used for NEOH planning.

Temperature Criteria

The temperature criteria depends on the species and specific life stage. Because of the large die1 change in temperature, the maximum temperature criteria for adult holding, incubation, early rearing, and rearing are based on the 75th percentile of the daily maximum temperature. The development of the temperature criteria presented in this report can based on the examination of detailed temperatures data at 5 spring chinook hatcheries (see Appendix A).

For April - July, the maximum temperature criteria for the holding of adult spring chinook is 63 F based on the daily maximum temperature. Three out of four days, the daily maximum temperature will not exceed 63 F. One out four days the daily maximum temperature will exceed 63 F. Detailed percentile temperature data for all available stations within the Northeast Oregon Project area are presented in Appendix B.

TABLE 4

WATER QUALITY CRITERIA FOR SALMONIDS

Parameter		ADF&G[1]	SEP[2]	WDF[3]	USFWS[4]
Alkalinity		undetermined	>15		10-400
Aluminum		<0.01	<0.10	<0.01	
Ammonia (total as N)			<0.05		
Ammonia (un-ionized as N)		<0.010		0.010	<0.010
Arsenic		<0.05		<0.05	<0.05
Barium		<5.0		<5	<5
Cadmium	< 100 mg/L Alkalinity	<0.0005	<0.0003	<0.0002	<0.0004
	> 100 mg/L Alkalinity	<0.005			<0.003
Carbon Dioxide		<1.0	<10	<1	0-10
Chloride		<4.0 .			<4
Chlorine		<003			<0.03
Chromium		<0.03	<0.04	<0.01	<0.03
Copper	< 100 mg/L Alkalinity	<0.006	<0.0002	<0.05	<0.006
	> 100 mg/L Alkalinity	<0.03			
Dissolved Oxygen - mg/L (%)		>7.0	(>95)		(95-100)
Fluoride		<0.5		<0.5	<0.5
Hydrogen Sulfide		<0.003	<0.002	<0.003	<0.002
Hardness			>20	<200	10-400
Iron		<0.1	<0.3	<0.1	<0.15
Lead		<0.02	<0.004	<0.02	<0.03
Magnesium		<15		<15	needed
Manganese		<0.01	<0.1	<0.01	<0.01
Mercury		<0.0002	<0.0002	<0.0002	<0.00005
Nickel		<0.01	<0.045	<0.01	<0.01
Nitrogen Gas (%)		<103		<110	<110
Nitrate as N		<0.2		<0.2	0-0.7
Nitrite as N		<0.03	<0.015	<0.03	<0.03
Ozone					<0.005
PCBs					<0.002
Petroleum (Oil)		<0.001			
pH (units)		6.5-8.0	7.2-8.5	6.5-8.0	6.5-8.0
Potassium		<5.0		<5	<5
Salinity (mg/kg)		<5.0			
Selenium		<0.01	<0.050	<0.002	<0.01
Silver		<0.003	<0.0001	<0.003	<0.003
Zinc		<0.005		<0.005	<0.03
Sodium		<75		<75	<75
Sulfate		<50		<50	<50
Suspended Solids			<3		
Temperature (°C)		0-15	5-10		
Total Dissolved Solids		<400			
Total Settleable Solids		<80			<80
Total Gas Pressure (%)		<110	<103		

All units mg/L unless otherwise noted

(1) ADF&G 1983.

(2) Shepherd 1984.

(3)Schroeder 1984.

(4) Piper et al. 1982.

Carbon Dioxide

To determine carbon dioxide water quality criteria, it is also necessary to define critical levels. Recently, Piper et al. (1982) proposed an upper limit concentration of 10 mg/l, although others have suggested up to 20 mg/l (SECL, 1983). For NEOH planning 10 mg/l will be used as the carbon dioxide criterion. The carbon dioxide criteria may also depend on the relationship between carbon dioxide, alkalinity, and pH.

pH

Criteria for pH depend on species, life stage, and ionic composition of the water. For incubation and early fry rearing, SECL (1983) recommended that the pH be maintained between 6.5 - 8.5. This range will be used for NEOH planning.

Temperature Criteria

The temperature criteria depends on the species and specific life stage. Because of the large die1 change in temperature, the maximum temperature criteria for adult holding, incubation, early rearing, and rearing are based on the 75th percentile of the daily maximum temperature. The development of the temperature criteria presented in this report can based on the examination of detailed temperatures data at 5 spring chinook hatcheries (see Appendix A).

For April- July, the maximum temperature criteria for the holding of adult spring chinook is 63 F based on the daily maximum temperature. Three out of four days, the daily maximum temperature will not exceed 63 F. One out four days the daily maximum temperature will exceed 63 F. Detailed percentile temperature data for all available stations within the Northeast Oregon Project area are presented in Appendix B.

TABLE 4

WATER QUALITY CRITERIA FOR SALMONIDS

Parameter	ADF&G 1	SEP[2]	WDF[3]	USFWS[4]
Alkalinity	undetermined	>15		10-400
Aluminum	<0.01	<0.10	<0.01	
Ammonia (total as N)		<0.05		
Ammonia (un-ionized as N)	<0.010		0.010	<0.010
Arsenic	<0.05		<0.05	<0.05
Barium	<5.0		<5	<5
Cadmium < 100 mg/L Alkalinity	<0.0005	<0.0003	<0.0002	<0.0004
> 100 mg/L Alkalinity	<0.005			<0.003
Carbon Dioxide	<1.0	<10	<1	0-10
Chloride	<4.0			<4
Chlorine	<003			<0.03
Chromium	<0.03	<0.04	<0.01	<0.03
Copper < 100 mg,L Alkalinity	<0.006	<0.0002	<0.05	<0.006
> 100 mg/L, Alkalinity	<0.03			
Dissolved Oxygen - mg/L (%)	>7.0	(>95)		(95-100)
Fluoride	<0.5		<0.5	<0.5
Hydrogen Sulfide	<0.003	<0.002	<0.003	<0.002
Hardness		>20	<200	10-400
Iron	<0.1	<0.3	<0.1	<0.15
Lead	<0.02	<0.004	<0.02	<0.03
Magnesium	<15		<15	needed
Manganese	<0.01	<0.1	<0.01	<0.01
Mercury	<0.0002	<0.0002	<0.0002	<0.00005
Nickel	<0.01	<0.045	<0.01	<0.01
Nitrogen Gas (%)	<103		<110	<110
Nitrate as N	<0.2		<0.2	0-0.7
Nitrite as N	<0.03	<0.015	<0.03	<0.03
Ozone				<0.005
PCBs				<0.002
Petroleum (Oil)	<0.001			
pH (units)	6.5-8.0	7.2-8.5	6.5-8.0	6.5-8.0
Potassium	<5.0		<5	<5
Salinity (mg/kg)	<5.0			
Selenium	<0.01	<0.050	<0.002	<0.01
Silver	<0.003	<0.0001	<0.003	<0.003
Zinc	<0.005		<0.005	<0.03
Sodium	<75		<75	<75
Sulfate	<50		<50	<50
Suspended Solids		<3		
Temperature (°C)	0-15	5-10		
Total Dissolved Solids	<400			
Total Settleable Solids	<80			<80
Total Gas Pressure (%)	<110	<103		

All units mg/L unless otherwise noted
(1) ADF&G 1983.
(2) Shepherd 1984.
(3)Schroeder 1984.
(4) Piper et al. 1982.

PROCESS CRITERIA

General Process Criteria

General process criteria for NEOH are shown on Table 5.

Table 5

Process Criteria for NEOH (Adult Hauling - Incubation)

Parameter	Spring Chinook	Fall Chinook	Summer Steelhead
Adult Hauling			
Date	Apr 15-Jul 15	Sep-Dec	Oct-May
Duration (total)	62	122	243
Weight (lb)	13	15	6
Adult Holding			
Date	Apr 15-Sep 15	Sep-Dec	Oct-May
Duration (total)	154	122	243
Weight (lb)	13	15	6
Temperature (F)			
Optimum	50	50	50
Average Monthly Range	45-55	45-55	40-55
Maximum Daily Temperature[a]	63 (Apr-Jul) 60 (Aug-Sep)	63	60
Density (cf/fish)	8	7	2.5
Flow (gpm/fish)	-1.5 + 0.05xT	-1.5 + 0.05xT	-0.5 + 0.05xT
Survival (%) (Capture-Spawning)	75	80	75
Spawning			
Date	Aug 5-Sep 15	Oct 15-Dec	Mar 15-May
Duration (total)	42	81	78
Female/Male Ratio	1:1	1:1	1:1
Eggs/female	4,200	4,500	5,200
Incubation			
Date	Aug 5 -Dec	Oct 15Feb	Mar 15-Jun
Duration (fertilization to feeding)	149	137	108
Eggs/Tray (1 female/tray)	4,200	4,500	5,200
Flow/8 trays (gpm)	6	6	6
Temperature (F)			
optimum	42->39->42[b]	52	52
Average Monthly Range	45-55	45-55	45-55
Maximum Daily Temperature[a]	60	60~	60
Survival (green egg to feeding)	90	90	90
DD to Feeding	1665	1665	975
Length at Feeding (inches)	1.34	1.45	1.02
Weight at Feeding (#/lb)	1100	1100	2800

(a) Maximum Daily Temperatures are based on 75 percentile values
(b) This temperature profile may be used to delay the development of the eggs

Table 5 (Continued)

Process Criteria for NEOH (Rearing)

Parameter	Spring Chinook	Fall Chinook	Summer Steelhead
Length-Weight (W =CL^3, inches, lb)			
C	$2,959x10^{-7}$	$2,959x10^{-7}$	$3,405x10^{-7}$
Early Rearing (Feeding to 200/lb)			
Date	Nov-Jan	Jan-Mar	May-Jul
Duration (d)	70-90	70-90	70-90
Length at Start (inches)	1.34	1.45	1.02
Weight at Start (#/lb)	1100-1350	1100	2800
Temperature (F)			
Optimum (River-Well Water Mix)	50	50	50
Average Monthly	35-60	35-60	35-60
Maximum Daily Temperature[a]	65	65	65
DI (small indoor rearing units)	1.00	1.00	1.00
DI (outdoor production raceways)		0.30	
FI (based on Table 12)	FI	FI	FI
Survival (%)	[illegible]	[illegible]	[illegible]
DD /inch	840	840	810
Length at End (inches)	2.57	2.57	2.45
Weight at End (#/lb)	200	200	200
Rearing (200/lb to Full Term)			
Date	Dee-May 15	Apr-May 15	Jun-Apr
Duration (d)	530-550	50-60	270-300
Length at Start (inches)	2.57	2.57	2.45
Weight at Start (#/lb)	200	200	200
Temperature (F)			
Optimum	55	55	55
Average Monthly	35-65	35-65	35-65
Maximum Daily Temperature[a]	70	70	70
DI	0.18	0.18	0.18
FI (based on Table 12)	FI/1.25	FI/1.25	FI/1.25
Survival (%)	84	88	88
DD/inch	840	840	810
Length at End (inches)	6.08-6.97	3.64-4.39	8.37
Weight at End (#/lb)	15-10	70-40	5

[a] Maximum Daily Temperatures are based on 75 percentile values

Table 5 (Continued)

Process Criteria for NEOH (Direct Release and Acclimation)

Parameter	Spring Chinook	Fall Chinook	Summer Steelhead
Fry Hauling for Direct Release			
Date		May	
Length (inches)		3.64-4.39	
Weight (#/lb)		70-40	
survival (%)		99.7	
Direct Release			
Distance between sites (miles)		5-10	
Number of Fish/Release Site/Mile/Week		varies	
Smolt Hauling for Acclimation			
Date	Mar-May 15	Mar-May 15	Feb-Apr
Length (inches)	6.08-6.97	3.64-4.39	8.37
Weight (#/lb)	15-10	70-40	5
survival (%)	99.5	99.5	99.5
Acclimation and Release			
Date	April	Apr-May 15	Mar-Apr
Duration (d)	3 to 30	3 to 30	3 to 30
Distance between Sites (miles)	5-10	5-10	5-10
Length at Start (inches)	6.08-6.97	3.64-4.39	8.37
Weight at Start (#/lb)	15-10	70-40	5
Temperature (F)			
Optimum	55	55	55
Average Monthly	35-65	35-65	35-65
Maximum Daily Temperature[a]	70	70	70
DI	0.11	0.11	0.11
FI (based on Table 12)	FI/1.25	FI/1.25	FI/1.25
Survival (%)	99.5	99.5	99.5
DD/inch	no growth	no growth	no growth
Length at End (inches)	6.08-6.97	3.64-4.39	8.37
Weight at End (#/lb)	15-10	70-40	5

a Maximum Daily Temperatures are based on 75 percentile values

Table 5 (Continued)

Process Criteria for NEOH (Fed Fry)

Parameter	Spring Chinook	Fall Chinook	Summer Steelhead
Rearing (200/lb to Fed Fry)			
Date	Feb-Apr		
Duration (d)	20-30		
Length at Start (inches)	2.57		
Weight at Start (#/lb)	200		
Temperature (F) Optimum Average Monthly Maximum Daily Temperature[a]	 55 35-65 70		
DI	0.18		
FI (based on Table 12)	FI/1.25		
Survival (%)	92		
DD/inch	840		
Length at End (inches)	2.82		
Weight at End (#/lb\	150		
Fry Hauling for Fed Fry			
Date	Mar-Apr		
Length (inches)	2.82		
Weight (#/lb)	1.50		
Survival (%)	99.7		
Fed Fry Release			
Date	July		
Distance between sites (miles)	1-2		
Number of Fish/Release Site/Mile/Week	varies		

a Maximum Daily Temperatures are based on 75 percentile values

Length-Weight Relationship

The weight of a fish in relation to its length, at any time, is expressed as follows:

$$W = C \times L^3$$

where W = weight in pounds, L = length in inches, and C is the condition factor for the specific species.

Development Rate

Eggs. Egg development rate is based on daily degree-days (DD) using a base temperature of 32°F. For example, 1665 DD are needed to develop from fertilization to feeding. The daily degree day for a single day is equal to:

$$DD = (\text{Temperature in }°F - 32)$$

The total degree day for n days is equal to

$$DD = \sum_{i=1}^{n} (\text{Temperature}_i - 32)$$

Eggs incubated in 50 °F water for 30 days have accumulated 540 DD.

Fry. Fry development rate is based on the number of daily degree days (DD) to achieve an inch of growth. For example, 840 DD are needed per inch of growth for spring chinook. The daily degree days for growth are defined in a similar manner as for eggs. The change in length (ΔL) is equal to:

$$\Delta L(\text{inches}) = \frac{\sum_{i=1}^{n} (\text{Temperature}_i - 32)}{840}$$

Fry reared in 50 °F water for 30 days have accumulated 540 DD and increase 0.64 inches in length. The final length at the end of the 30 days would be equal to

$$\text{Length}_{\text{final}} = \text{Length}_{\text{initial}} + 0.64$$

Feed Consumption

The amount of food to be fed to the fish must be known in order to predict oxygen demand, ammonia concentrations, and suspended solids production levels. Generally, the daily feeding rate is determined from information provided by feed companies or as summarized in Piper et al. (1982). This information can be converted to simple feeding coefficients (F_C) that relate feeding rate to water temperatures and growth rate.

TABLE 6

FEEDING COEFFICIENT AT VARIOUS WATER TEMPERATURES (a)

Temperature (°F)	Feeding Coefficient (b)
46	7.38
49	8.54
52	9.70
55	10.86
58	12.02

(a) Based on feeding rates presented in Table 25 of Piper et al. (1982) for fish growing at 900 DD/inch length increase.

(b) Feeding Coefficient = (Water temperature - 26.94) x 0.387

To determine the daily amount of feed offered to fish, one would use the formula:

% of Body Weight to Feed = Fc/L

Where Fc is the feeding coefficient, and L is the length of fish in inches.

Oxygen Consumption

The calculations of oxygen levels and consumption will be based on the following relationship between feed (F) and oxygen consumption in raceways (Oc):

$$Oc = 0.25 \times F$$

Stated in another way, for each 100 pounds of food introduced to a raceway, 25 pounds of oxygen will be consumed in that raceway in the same period of time. This is probably conservative in that a general value of Oc=O.22 x F was proposed by Willoughby for a dry diet. Values of Oc ranging from 0.22 to 0.25 are probably valid for fingerlings under production conditions. Higher values may needed for smaller fish and for fry and fingerlings fed restricted rations.

Ammonia Production

The calculation of ammonia production is based on the following relationship between feed (F) and total ammonia produced, TAN (total ammonia expressed as nitrogen):

$$TAN = 0.029 \times F$$

This relationship is based on work by Mayo & Liao at the Cowlitz Trout Hatchery and verified by other sources.

Carbon Dioxide

As proposed by Piper et al (1982) the dissolved carbon dioxide produced per pound of feed will be based on the following relationship between feed (F) and carbon dioxide production (Cp):

$$Cp = 0.28 \times F$$

Suspended Solids

Suspended solids sources in the effluent of a production unit consist of materials in the influent water, fecal solids, uneaten feed, and other materials that have fallen or have been blown in the water. Pollution control requirements may be based in part on effluent suspended solids (SuS) levels. The calculations of SuS generated will be based on the following relationship between feed (F) and total SuS:

$$SuS = 0.35 \times F$$

Because of the number of materials that can contribute to suspended solids, operational considerations, and site-specific factors, the above relationship may not be valid for all locations.

Phosphate

Phosphate sources in intensive culture include uneaten feed, fecal matter, and direct excretion from the kidneys. The amount of phosphates added to the water also depends on the type of solids removal system used. Commonly, the amount of phosphate added to the diet is in excess of that needed by the fish. Because of discharge restrictions on phosphate in North America and Europe, major research has been directed towards the reduction in the amount of phosphate in the diet and development of operational procedures to reduce the phosphate concentration in the discharge water. Based on work reported by Liao and Mayo (1974), the phosphate production rate will be based on the following relationship between feed (F) and total P04:

$$PO4 = 0.016 \times F$$

Rearing Mortalities

To develop a hatchery model, it is necessary to have an estimate of mortalities that may be expected in the facility. Typically, survival is lowest at the beginning of a cycle and highest at the end. Survival assumptions for NEOH are shown on Table 7.

Rearing Density

Density criteria (maximum weight of fish per cubic foot) is developed in terms of the Density Index approach. The Density Index (DI) is:

$$DI = \frac{\text{Density(lb/cf)}}{\text{Length of fish (inches)}} \quad \text{or}$$

$$\text{Density } (lb/ft^3) = DI \times \text{length in inches}$$

Detailed information on DIs for a number of similar projects is shown on Tables 8 and 9.

TABLE 7

ASSUMED SURVIVAL RATES BY LIFE STAGE AND SPECIES

Life Stage	Spring Chinook	Fall Chinook	Summer S teelhead
Capture-Spawning	75	80	75
Eggs-Smolt	72	75	85
Eggs-Feeding	90 (assumed)	90 (assumed)	95 (assumed)
Feeding-200/#	95 (assumed)	95(assumed)	95 (assumed)
200/#-Release	84 (computed)	88 (computed)	94 (computed)
Smolt Hauling	99.5 (assumed)	99.5 (assumed)	99.5 (assumed)
Acclimation Ponds	99.5 (assumed)	99.5 (assumed)	99.5 (assumed)

TABLE 8

DENSITY AND FLOW INDICES USED BY DIFFERENT AGENCIES IN THE PACIFIC NORTHWEST FOR OUTDOOR RACEWAYS (>800/LB.)

Agency/Project	Density Index (lb/(cf∑in)	Flow Index a (lb/gpm∑in)
ODF&W Design Values (Based on FMC, 1984)	0.22-0.30 (mean=0.26)	65
ODF&W (Recent Hatcheries)		
Willamette (standard)	0.16 (max)	50
Umatilla (ChS)	0.16 (max)	78
Umatilla (ChF)	0.17 (max)	83
WDF Design Values	undetermined	100
WDF (Recent Hatcheries)		
Issaquah (chinook)	0.08 (max)	96
Lyons Ferry (ChS)	0.03-0.23 (mean = 0.10)	60
Lyons Ferry (ChF)	0.06-0.27 (mean = 0.16)	60
YakimaKlickitat Production Design Values	0.175 raceways.(max) 0.150 ponds (max) 0.110 acclimation ponds (max)	$4\left[\frac{\text{Available DO}}{\text{(\% Feeding)(Length)}}\right]$ b
US Fish & Wildlife Service		
Dworshak National Fish Hatchery (Steelhead)	0.25 (max)	--
Makah National Fish Hatchery Fall Chinook)	0.50 (max)	—
piper et al., 1982 (Salmon and Trout)	0.50 (max)	100
Bonneville Power Administration (Assessment of Present Anadromous Fish Production . . . . 1990)	0.25 ChS (max) 0.30 ChF (max) 0.25 Steelhead (max)	100

(a) Percent of Table 12.
(b) Depending on specific rearing cycle and temperatures, the FIs computed from this equation range from 1 10- 1 30% of the values shown on Table 12.

TABLE 9

DENSITY AND FLOW INDICES USED BY VARIOUS AGENCIES IN THE PACIFIC NORTHWEST FOR EARLY REARING (<800/LB.)

Agency/Project	Density Index (lb/(cfΣin)	Flow Index [a] (lb/gpmΣin)
Lookingglass Hatchery Spring Chinook		
First stocking (up to 600/#-700#)	0.50-0.55	114-126
After split (up to 250/#-500/#)	0.28-0.45	47-74
Umatilla Hatchery Fall Chinook (in outdoor ponds)[b]	0.30	--
South Tacoma Hatchery Rainbow Trout	1.5-1.7	65-86
Cowlitz Hatchery Steelhead and Cutthroat	2.3-2.5	104-114
Mossyrock Hatchery Rainbow Trout	Similar to cowlitz	Similar to Cowlitz

(a) Percent of Table 12.
(b) Outdoor ponds are acceptable if groundwater is available to increase the water temperature for the first 2-3 weeks of rearing to assure that the fish start to fed. If cold surface water is used for early rearing, serious problems with pin-heads may occur.

TABLE 10

PROPOSED DENSITY INDICES BY LIFE STAGE FOR NEOH

Phase	**Density Index (lb/cf∑in)**
Early Rearing	1.00 (possibly up to 2.00 depending on feeding response
Rearing in Raceways	0.18
Acclimation in Raceways	0.18
Acclimation in Earthen Ponds	0.11
Acclimation in Large Earthen Ponds (a)	0.11
Acclimation in Side Channels (a)	0.11

(a) Assumed to be similar to DI for earthen ponds, no direct experience.

Flow Requirements

The water requirements in an intensive culture salmon hatchery are determined by six factors: (1) The amount of oxygen consumed, (2) the oxygen levels in the influent water supplied to the raceways, (3) tolerance to lowered oxygen levels, (4) ammonia in the incoming water supply, (5) metabolites, primarily ammonia, carbon dioxide, and suspended solids, produced in the rearing process, and (6) tolerance to the metabolites, specifically un-ionized ammonia, carbon dioxide and suspended solids. In turn, oxygen consumption and metabolite production is directly related to the amount of feed.

Flow requirements for adult holding as a function of temperature (°F) are based on Senn et. al. (1984) and are shown on Table 11.

TABLE 11

FLOW REQUIREMENTS AS A FUNCTION OF TEMPERATURE (T)

Species	gpm/fish
Spring Chinook	-1.5 + 0.05T
Fall Chinook	-1.5 + 0.05T
Summer S teelhead	-0.5 + 0.05T

Loading criteria for rearing (pounds of fish per gallon per minute) are developed in terms of the Flow Index approach. The Flow Index (FI) is:

$$FI = \frac{\text{Loading (lb/gpm)}}{\text{Length of fish (inches)}}$$

or

$$\text{Loading (lb/gpm)} = \text{FI x Length in inches}$$

The flow indices proposed for NEOH are shown on Table 12 and are based on Piper et al. (1982). For rearing and acclimation, Piper's values are divided by a factor equal to 1.25. Piper's table is based on a minimum DO of 5 mg/L versus the 7 mg/L used in this project. Therefore, the FI must be reduced and more water is needed per lb of fish. The sites under consideration for the NEOH project range in elevation from approximately 900 to over 4,600 feet. Sites at different elevations will have slightly different flow indices.

TABLE 12

FLOW INDEX (LB/GPM•IN) AS A FUNCTION OF WATER TEMPERATURE AND ELEVATION

Temp (°F)	Elevation (Feet)									
	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
40	2.66	2.62	2.58	2.54	2.49	2.45	2.41	2.37	2.33	2.29
41	2.56	2.52	2.48	2.44	2.40	2.36	2.32	2.28	2.24	2.20
42	2.47	2.43	2.39	2.35	2.31	2.27	2.23	2.20	2.16	2.12
43	2.37	2.34	2.30	2.26	2.22	2.19	2.15	2.11	2.07	2.04
44	2.29	2.25	2.21	2.18	2.14	2.10	2.07	2.03	1.99	1.96
45	2.20	2.16	2.13	2.09	2.06	2.02	1.99	1.95	1.91	1.88
46	2.11	2.08	2.05	2.01	1.98	1.94	1.91	1.87	1.84	1.81
47	2.03	2.00	1.97	1.93	1.90	1.87	1.83	1.80	1.77	1.73
48	1.96	1.92	1.89	1.86	1.83	1.79	1.76	1.73	1.70	1.66
49	1.88	1.85	1.82	1.79	1.76	1.72	1.69	1.66	1.63	1.60
50	1.81	1.78	1.75	1.72	1.69	1.66	1.63	1.60	1.57	1.54
51	1.74	1.71	1.68	1.65	1.62	1.59	1.56	1.53	1.50	1.48
52	1.67	1.64	1.62	1.59	1.56	1.53	1.50	1.47	1.45	1.42
53	1.61	1.58	1.55	1.53	1.50	1.47	1.45	1.42	1.39	1.36
54	1.55	1.52	1.50	1.47	1.44	1.42	1.39	1.37	1.34	1.31
55	1.49	1.47	1.44	1.42	1.39	1.37	1.34	1.32	1.29	1.27
56	1.44	1.41	1.39	1.37	1.34	1.32	1.29	1.27	1.25	1.22
57	1.39	1.37	1.34	1.32	1.30	1.27	1.25	1.23	1.20	1.18
58	1.34	1.32	1.30	1.28	1.25	1.23	1.21	1.19	1.17	1.14
59	1.30	1.28	1.26	1.24	1.22	1.19	1.17	1.15	1.13	1.11
60	1.26	1.24	1.22	1.20	1.18	1.16	1.14	1.12	1.10	1.08
61	1.22	1.20	1.19	1.17	1.15	1.13	1.11	1.09	1.07	1.05
62	1.19	1.17	1.16	1.14	1.12	1.10	1.08	1.07	1.05	1.03
63	1.16	1.15	1.13	1.11	1.10	1.08	1.06	1.04	1.03	1.01
64	1.14	1.12	1.11	1.09	1.07	1.06	1.04	1.03	1.01	1.00

This table is based on optimum index of FI = 1.5 at 50F and 5,000 feet elevation (Piper et al., 1982). The dissolved oxygen concentration is assumed to be at or near 100% saturation and a minimum acceptable DO = 5.0 mg/L.

To generate FIs for the NEOH Project, the original data (Piper et al., 1982) was used to product the following regression equation:

$$FI = 7.937 - 0.147T + 1.001E - 5(T^3) - 1.643E - 4(EL) + 2.075E - 6(T * EL)$$
$$r^2 = 0.999$$

where

T = Temperature (°F)

EL = Elevation above sea level (ft).

PROGRAM ALTERNATIVES

INTRODUCTION

This section presents a summary of the production plans for each subbasin and stock, the preferred and alternative sites within each subbasin to carry out the production plan, and a discussion of the feasibility of incorporating production into a central incubation facility for two or more subbasins versus planning for individual production facilities in each subbasin.

SUBBASINS

The NEOH study area can be subdivided into eight combinations of river subbasins and fish stocks for site analysis and planning purposes. These include:

Spring Chinook	Upper Grande Ronde River
	Catherine Creek
	Wallowa-Lostine Rivers
	Imnaha River
	Walla Walla and Touchet Rivers
Fall Chinook	Grande Ronde River
	Imnaha River
Steelhead	Walla Walla River.

SUBBASIN PROGRAMS

Tables 13 through 20 list the preferred facility locations for fish production phases from adult capture through incubation, rearing, and release for each subbasin production plan. These preferred locations were developed through a site screening process described in the Final Siting Report. Alternative facility locations for the adult capture through full term rearing phases are also shown where appropriate. In some cases, the alternative sites are located in one or more adjacent subbasins. In all cases the final rearing / acclimation / direct release sites listed are based on information contained in the final subbasin plans.

Tables 13 through 20 form the basis for the conceptual layouts developed for each site. The layouts are presented in subsequent sections, by subbasin, for facilities identified at a particular site.

TABLE 13

UPPER GRANDE RONDE SPRING CHINOOK

Broodstock Source	Broodstock Number	production Goal No. & Size	Acclimation Sites	Siting Report Reference
Catherine Creek	74 (Limited to 50% of the run)	100,000 @15-20/lb	2 sites above Limber Jim Creek: (1) Upper Vey Meadows and (2) Sheep Creek	Table 2 Group 9

Adult Capture: Preferred Site - Davis Dam on Catherine Creek (see Table 14)
Alternative 1 - Vey Meadows at Splash Dam (a)

Adult Holding: Preferred Site - Upper Vey Meadows
Alternative 1 - Catherine Creek incubation site

Incubation: (b) Preferred Site - Catherine Creek incubation site
Alternative 1 - Strathearn Ranch

Early Rearing: Preferred Site - Catherine Creek incubation site
Alternative 1 - Stratheam Ranch

Full Term Rearing: Preferred Site - Catherine Creek incubation site
Alternative 1 - Stratheam Ranch

Final Rearing/Acclimation and/or Direct Release Sites:

Site 1 - Upper Vey Meadows (69,000 smolts)
Site 2 - Sheep Creek (31,000 smolts)

(a) To be used in future as returns increase. Will collect adults initially at Catherine Creek capture site.

(b) Preferred incubation site dependent on outcome of further groundwater investigations. Catherine Creek incubation site includes either the Union or OSU sites. Stratheam Ranch site would be used if Catherine Creek incubation site is not feasible based on groundwater investigations.

TABLE 14

CATHERINE CREEK SPRING CHINOOK

Broodstock **Source**	Broodstock Number	Production Goal No. & Size	Acclimation Sites	Siting Report Reference
Catherine Creek	222 (Limited to 50% of the run)	161,000 @ 15-20/lb	1 site on mainstem Catherine Creek	Table 2 Group 7
		112,000 @ 15 20/lb	N & S. forks confluence site	Table 2 Group 8
		28,000 @ 15-20/lb	Indian Creek site	Table 2 Group 10
Catherine Creek	70	94,500 @ 20/lb	OSU site	EIP measure 2.3
Rapid River	260	350,000 @ 20/lb	OSU site	EIP measure 2.3

Adult Capture: Preferred Site - Davis Dam (EIP site)
Alternative 1 - Catherine Creek at Union
Alternative 2 - OSU Site

Adult Holding: Preferred Site - OSU Site (NEOH + EIP)
Alternative 1 - Catherine Creek at Union ~~JNEOH only)~~

Incubation: (a) Preferred Site - OSU Site
Alternative 1 - Catherine Creek at Union
Alternative 2 - Strathearn Ranch

Early Rearing: Preferred Site - OSU site
Alternative 1 - Catherine Creek at Union
Alternative 2 -. Strathearn Ranch

Full Term Rearing: Preferred Site - OSU site
Alternative 1 - Catherine Creek at Union
Alternative 2 - Stratheam Ranch

Final Rearing/Acclimation and/or Direct Release Sites :

Site 1 - N & S Fork Confluence (112,000 smolts)
Site 2 - OSU Site (3 groups:161,OOO, 94,500 [EIP], 350,000 [EIP]
Site 3 - Indian Creek (28,000 smolts)

(a) Preferred alternative incubation site dependent on outcome of further groundwater investigations. Both the Union and OSU sites have moderate to good groundwater potential. Union site probably has the better overall groundwater potential.

TABLE 15

WALLOWA-LOSTINE SPRING CHINOOK

Broodstock Source	Broodstock Number	Production Goal No. & Size	Acclimation or Release Sites	Siting Report Reference
Lostine River	400	516,000 @ 15/lb	1 acclimation site on Lostine	Table 2 Group 4
		150,000 @ 150/lb	7 release sites on Lostine	Table 2 Group 5
		28,000@ 15/lb	1 acclimation site at Bear Creek	Table 2 Group 6

Adult Capture: Preferred Site - Strathearn Ranch
Alternative 1 - Cross Valley Diversion (Clearwater Ditch) (a)

Adult Holding: Preferred Site - Stratheam Ranch
Alternative 1 - Wallowa Hatchery (has capacity for 400 adult ChS with no changes)
Alternative 2 - Big Canyon Creek (has capacity for 80 additional ChS adults with no changes)

Incubation: Preferred Site - Stratheam Ranch
Alternative 1 - WallowaHatchery
Alternative 2 - Minam - Wallowa Confluence (b)
Alternative 3 - Catherine Creek incubation site

Early Rearing: Preferred Site - Stratheam Ranch
Alternative 1 - Minam - Wallowa Confluence
Alternative 2 - Catherine Creek incubation site

Full Term Rearing: Preferred Site - Stratheam Ranch
Alternative 1 - Catherine Creek incubation site

Final Rearing/Acclimation and/or Direct Release Sites:

Site 1 - Stratheam Ranch (516,000 smolts)
Site 2 - Hurricane Creek (a)
Site 3 - Bear Creek (c) (28,000 smolts in "temporary" acclimation facility
Additional Sites - 7 direct release sites on upper Lostine currently in use (150,000 fry, require no design work)

Notes:
(a) Will remain as identified alternative but no conceptual design planned at this time.
(b) Potential ChS site if developed for ChF incubation and early rearing.

TABLE 16

IMNAHA SPRING CHINOOK

Broodstock Source	Broodstock Number	Production Goal No. & Size	Acclimation or Direct Release Sites	Siting Report Reference
Imnaha Wild Stock	260	392,500 @ 15-20/lb	2-3 acclimation sites between Gumboot and Freezeout Cks.	Table 3 Group 14
	132	230,000 @ 150,'lb	direct release	Table 3 Group 15

Adult Capture: Preferred Site - Gumboot Creek (Fish Weir)
Alternative 1 - Wayne Marks Ranch

Adult Holding: Preferred Site - Wayne Marks Ranch
Alternative 1 - Gumboot Creek (Fish Weir)

Incubation: Preferred Site - Wayne Marks Ranch
Alternative 1 - Stratheam Ranch
Alternative 2 - Catherine Creek at Union

Early Rearing: Preferred Site - Wayne Marks Ranch
Alternative 1 - Stratheam Ranch
Alternative 2 - Catherine Creek at Union

Full Term Rearing: Preferred Site - Wayne Marks Ranch
Alternative 1 - Strathearn Ranch
Alternative 2 - Catherine Creek at Union

Final Rearing/Acclimation and/or Direct Release Sites:

Site 1 - Big Sheep - Lick Creek Confluence (230,000 fry)

3 acclimation sites between Gumboot and Freezeout Creeks using "natural" side channel type facility (392,500 smolts):

Site 2 - Mahogany Creek
Site 3 - Stock Pond
Site 4 - College Creek

TABLE 17

WALLA WALLA AND TOUCHET SPRING CHINOOK

Broodstock Source	Broodstock Number	Production Goal No. & Size	Acclimation or Release Sites	Siting Report Reference
Carson stock	559	350,000-400,000 @10/lb	S. Fork Walla Walla	Table 4 Group 1
		200,000-250,000 @ lo/lb	upper Touchet	Table 4 Group 2
Umatilla River (Carson stock)	548 (a)	589,000 @ lo/lb	upper Umatilla mainstem	Table 5 Group 17

Adult Capture: Preferred Site - Railroad Bridge on mainstem Walla Walla

Adult Holding: Preferred Site - Russell Walker property
Alternative 1 - Harris Park No. 1

Incubation: Preferred Site - Russell Walker property
Alternative 1 - Harris Park No. 1

Early Rearing: Preferred Site - Russell Walker property
Alternative 1 - Harris Park No. 1

Full Term Rearing: Preferred Site - Russell Walker property
Alternative 1 - Harris Park No. 1

Final Rearing/Acclimation and/or Direct Release Sites:

S. Fork Walla Walla sites (350,000-400,000 smolts)
Site 1 - Russell Walker property
Site 2 - Harris Park No. 1 (to be used if Russell Walker site not developed)

Touchet River sites (1 to be selected: 200,000-250,000 smolts)
Site 3 - Pond at FS boundary on North Fork
Site 4 - **A** site between Wolf Fork and South Fork confluence with the North Fork Touchet

(a) Umatilla component of NEOH production.

TABLE 18

GRANDE RONDE FALL CHINOOK

Broodstock source	Broodstock Number	Production Goal No. & Size	Acclimation or Direct Release Sites	Siting Report Reference
Wenatchee Stock (October spawners) [Snake River stock is potential]	640	1,350,000 @ 40-50/lb	Direct release at 7 sites on mainstem Grande Ronde and Wallowa Rivers	Table 2 Group 11

Adult Capture: (a) preferred Site - existing Wenatchee stock collection site
Alternative 1 - Snake River dams (if Snake River stock is used)
Alternative 2 - Minam-Wallowa confluence

Adult Holding: Preferred Site - Minam - Wallowa Confluence
Alternative 1 - Lyons Ferry (existing facility)

Incubation: (b) Preferred Site - Minam - Wallowa Confluence
Alternative 1 - Catherine Creek incubation site
Alternative 2 - Lookingglass Hatchery

Early Rearing: Preferred Site - Minam - Wallowa Confluence
Alternative 1 - Catherine Creek incubation site
Alternative 2 - Lookingglass Hatchery

Full Term Rearing: Preferred Site - Minam - Wallowa Confluence
Alternative 1 - Catherine Creek incubation site
Alternative 2 - Lookingglass Hatchery

Final Rearing/Acclimation and/or Direct Release Sites (c):

Site 1 - Flora Grade (Schoolbus Flats) (develop existing side-channel)
Site 2 - Cottonwood Creek (use existing pond, develop water supply)
Site 3 - Minam - Wallowa Confluence

(a) Initial use of Wenatchee broodstock to rebuild the run is preferred. Snake River stock is a second choice for broodstock if Wenatchee stock cannot be used. Capture facility at Minam-Wallowa confluence will be planned and designed for potential future use.

(b) Preferred alternative incubation site dependent on outcome of further groundwater investigations. Depending on groundwater investigations, there may be opportunity to combine ChF and ChS incubation at one facility.

(c) These sites will be designed as the initial acclimation/release sites. Additional sites may be needed in future as total production goals are approached. If Snake River stock is used, Cottonwood Creek would be the only final rearing/release site.

TABLE 19

IMNAHA FALL CHINOOK

Broodstock Source	Broodstock Number	Production Goal No. & Size	Acclimation or Direct Release Sites	Siting Report Reference
Snake River Stock (November spawner)	66	120,000 @ 7O/lb	Direct release on lower Imnaha at Marr Ranch	Table 3 Group 16

Adult Capture (a): Preferred Site - Snake River dams
Alternative 2 - Gene Marr Ranch

Adult Holding: Preferred Site - Lyons Ferry (existing facility)
Alternative 1 - Gene Marr Ranch

Incubation: (b) Preferred Site - Gene Marr Ranch

Early Rearing: Preferred Site - Gene Marr Ranch

Full Term Rearing: Preferred Site - Gene Marr Ranch

Final Rearing/Acclimation and/or Direct Release Sites:

Site 1 - Gene Marr Ranch (120,000 fish)

Notes:

(a) Initial use of Lyons Ferry (or other Snake River) broodstock to rebuild the run. Facility required when sufficient adults returning for broodstock capture.

(b) Assuming use of Falls Creek for incubation water supply.

TABLE 20

WALLA WALLA STEELHEAD

Broodstock Source	Broodstock Number	Production Goal No. & Size	Acclimation or Direct Release Sites	Siting Report Reference
Walla Walla River Stock	80	100,000 @ 5/lb	1 Final rearing / release site on S Fork Walla **Walla**	Table 5 Group 3

Adult Capture: Preferred Site - NE 8th St. Bridge

Adult Holding: Preferred Site - Russell Walker property
Alternative 1 - Harris Park No. 1

Incubation: Preferred Site - Umatilla Hatchery (a)
Alternative 1 - Russell Walker property
Alternative 2 - Harris Park No. 1

Early Rearing: Preferred Site - Umatilla Hatchery (a)
Alternative 1 - Russell Walker property
Alternative 2 - Harris Park No. 1

Full Term Rearing: Preferred Site - Umatilla Hatchery (a)
Alternative 1 - Russell Walker property
Alternative 2 - Harris Park No. 1

Final Rearing/Acclimation and/or Direct Release Sites:

Site 1 - Russell Walker property (100,000 fish)
Site 2 - Harris Park No. 1 (if Site 1 is not used)

Notes:
(a) This alternative would involve transferring the Walla Walla steelhead production to the Umatilla Hatchery, and in exchange, an equivalent amount of Umatilla Hatchery ChS production would be transferred to the Russell Walker site.

SITE LAYOUTS FOR UPPER GRANDE RONDE AND CATHERINE CREEK SPRING CHINOOK PROGRAM

INTRODUCTION

This section presents the site layouts of the facilities required for the Upper Grande Ronde and Catherine Creek Spring Chinook Program. These facilities and the preferred / alternative sites were listed in Table 13 for the Upper Grande Ronde and 14 for Catherine Creek. Upper Grande Ronde sites containing facilities include adult holding at Upper Vey Meadows and final rearing / acclimation / direct release sites at Upper Vey Meadows and Sheep Creek (Figure 2). Adult capture, incubation, early rearing, and full term rearing facilities are proposed to be located within the Catherine Creek subbasin at the location of the Catherine Creek hatchery (either the OSU site or the Catherine Creek at Union site). These Catherine Creek facilities are described in the section on Site Layouts for Catherine Creek Spring Chinook Program and are not reproduced here.

An adult capture site in the Upper Grande Ronde subbasin is planned for the future as run size increases. The location is at the downstream end of Vey Meadows at the site of a former splash dam. Although the preferred adult holding site is identified as Upper Vey Meadows, it may be that this site is not used for adult holding until the run size increases and adult capture occurs within the subbasin. Adult holding for Upper Grande Ronde broodstock collected at Davis Dam on Catherine Creek is more likely to occur at the OSU site on Catherine Creek due to this sites proximity to adult collection, ample space available, and suitable water quality and quantity.

Catherine Creek preferred sites for all production phases are located within the Catherine Creek subbasin (Figure 2). Two alternative sites are shown for a hatchery facility: Catherine Creek at Union and the OSU site. The OSU site is preferred because of space availability, water quality, and groundwater potential. Hatchery layouts are included for both these sites.

Catherine Creek sites also function as the location for proposed EIP facilities

MAXIMUM FACILITY REQUIREMENTS

Table 21 lists the maximum facility requirements for water supply (gpm) and volume (cf) required for the-upper Grande Ronde program. The proposed layout to meet these requirements is also listed. The following drawings present a proposed site layout, emphasizing the ability of the preferred site to meet the space requirements. The final layout of the facilities at a site may differ from that shown in these drawings.

As stated above, incubation, early rearing and full term rearing is to be carried out within the Catherine Creek subbasin and layouts for these facilities are presented in Section 6.

TABLE 21

MAXIMUM FACILITY REQUIREMENTS

UPPER GRANDE RONDE AND CATHERINE CREEK SPRING CHINOOK

Facility	Site	Water Supply (gpm)	Volume (cuft)	Proposed Layout
Incubation	UGR	25	139,236 eggs	4 stacks of 8 trays/stack
	Cath. Creek	74	4 17,708 eggs	13 stacks of 8 trays/stack
		Total=94	Total=l,174,305	Total=17
Early Rearing	UGR	95	225	4 fry troughs
	Cath. Creek	284	675	11 fry troughs
		Total=798	TotaI=l,898	Total=15, each trough 2O'x2.5'x1.25' deep
Adult Holding	UGR	88	592	1 raceway
	Cath. Creek	265	1,776	1 raceway
	EIP	393	2,640	2mceways
		Total=746	Total=5,008	Total=4 each lO'xlOO'x2.5' deep
ull Term Rearing	UGR	1,223	6,441	3 raceways
	Cath. Creek	4,275	19,324	8 raceways
		Total=5498	Total=25,765	Total=1 1, each lO'xlOO'x2.5' deep
Final Rearing	Upper Vey	884	6,872	pond.
Upper Grande Ronde	Sheep Creek	399	3,088	portable tank
Final Rearing	osu	6,539	52,582	ponds
Catherine Creek	N&S Forks	1,396	11,155	pond
	Indian Creek	318	2,789	portable tank

TABLE 21 (continued)

MAXIMUM FACILITY REQUIREMENTS

UPPER GRANDE RONDE AND CATHERINE CREEK SPRING CHINOOK

Facility	Site	Water Supply (gpm)	Volume (cuft)	Proposed Layout
Final Rearing				
EIP Program				
Catherine Creek	OSU	966	7,700	portable tanks
Rapid River		3,580	28,776	portable tanks
		Total EIP = 4,546	Total ElP = 36,476	

PRODUCTION TIMING AND TEMPERATURE CbNSIDERATIONS

The temperature data for the Upper Grande Ronde River and Catherine Creek Spring Chinook program is based on Lostine River temperatures from the Strathearn .Ranch site due to a limited period of record for the site specific Tempmentor (see Appendix B). For concept design purposes, this should be adequate for planning. Temperature criteria consideration for the site based on the use of surface water for all phases is presented in the following table for comparison of sites. During August and September, the surface water is slightly higher than the temperature criteria for adult holding. It is estimated that 400 gpm of 51 °F groundwater could be developed at this site. A small amount of heating and chilling is needed for incubation if surface water is used. Due to the relatively small amount of water used, temperature adjustment for incubation is generally not a significant problem.

Based on the production goals and growth rates presented in Table 5, four growth models were simulated (Table 22):

TABLE 22

INFLUENCE OF WATER SOURCE ON GROWTH RATE

UPPER GRANDE RONDE AND CATHERINE CREEK SPRING CHINOOK

Water Source	Actual Release Date @ 15/lb	Actual Release Date @ 20/lb	Desired Release Date	Comments
GW for Incubation and Early Rearing SW for Rearing	October 27	September 15	March - May 15	Use of GW results in too rapid growth to meet desired release dates
SW for Incubation, Early Rearing, and Rearing	March 2	October 13	March - May 15	Approximating SW temp. gives acceptable releasedate at 15/lb. Release at 20/lb is too early

GW = groundwater
SW = surface water or groundwater adjusted to the local surface water temperature

The use of groundwater for incubation and early rearing results in too rapid growth of spring chinook. Disinfected surface water or groundwater adjusted to the local surface water results in better timing. Timing problems are especially critical for the 20/lb fish. Groundwater can be used to cool the water during the summer to help adjust production timing.

Relative heating and cooling requirements are shown on Table 23.

TABLE. 23

COMPARISON OF ACTUAL TEMPERATURES, TEMPERATURE CRITERIA, AND DEGREE OF REQUIRED HEATING OR COOLING

Temperature Criteria - Spring Chinook - OSU Site- Catherine Creek

	Actual Temperature (°F)			Temperature Criteria (°F)				Required ΔT (°F)		
Month	10 % of Daily Min.	Mean of Daily Avg.	75 % of Daily Max.	Max Adult Holding	Min Incub	Max Incub	Max Rearing	Adult Holding	Incub	Rearing
Oct	37.6	43.6	52.0							
Nov	33.2	36.8	40.5							
Dec	32.0	34.0	36.5							
Jan	32.0	34.4	37.2							
Feb	33.6	37.2	42.1							
Mar	34.3	39.2	45.3							
Apr	35.6	41.2	47.9	63						
May	37.4	41.8	46.8	63						
Jun	38.0	43.2	49.1	63						
Jul	42.5	50.5	57.0	63						
Aug	49.6	55.1	61.9	60	38	60		-1.9	-1.9	
Sep	45.0	52.1	60.6	60	38	60		-0.6	-0.6	
Oct	37.6	43.6	52.0		38	60			+0.4	
Nov	33.2	36.8	40.5		38	60	63		+4.8	
Dec	32.0	34.0	36.5		38	60	63		+6.2	
Jan	32.0	34.4	37.2				63			
Feb	33.6	37.2	42.1				63			
Mar	34.3	39.2	45.3				63			
Apr	35.6	41.2	47.9				63			
May	37.4	41.8	46.8				63			
Jun	38.0	43.2	49.1				63			
Jul	42.5	50.5	57.0				63			
Aug	49.6	55.1	61.9				63			
Sep	45.0	52.1	60.6				63			
Oct	37.6	43.6	52.0				63			
Nov	33.2	36.8	40.5				63			
Dec	32.0	34.0	36.5				63			
Jan	32.0	34.4	37.2				63			
Feb	33.6	37.2	42.1				63			
Mar	34.3	39.2	45.3				63			
Apr	35.6	41.2	47.9				63			
May	37.4	41.8	46.8				63			
Jun	38.0	43.2	49.1							
Jul	42.5	50.5	57.0							
Aug;	49.6	55.1	61.9							
Sep	45.0	52.1	60.6							

SITE LAYOUTS

Upper Grande Ronde and Catherine Creek site layouts are depicted on the following figures.

PRELIMINARY COST ESTIMATES

Preliminary cost estimates (+50%, -35%) for the Upper Grande Ronde and Catherine Creek program are shown on Tables 24 through 28.

GRANDE RONDE DRAINAGE BASIN

CATHERINE CREEK AND UPPER GRANDE RONDE SPRING CHINOOK PROGRAM PREFERRED AND ALTERNATIVE SITES

LEGEND

FACILITY TYPES:

PREFERRED SITES:

- ADULT CAPTURE SITE
- ADULT HOLDING SITE
- HATCHERY SITE
- FULL TERM REARING SITE
- FINAL REARING/ACCLIMATION/ DIRECT RELEASE SITE

ALTERNATIVE SITES.'

- ADULT CAPTURE SITE
- ADULT HOLDING SITE
- HATCHERY SITE
- FULL TERM REARING SITE
- FINAL REARING/ACCLIMATION/ DIRECT RELEASE SITE

STREAMFLOW GAGES

- A 13333000
- B 13332500
- C 13323500
- D 13319000
- E 13318800
- F 13318500
- G 13331500
- H 13330500
- I 13330000
- J 13329500
- K 13327500
- L 13323600
- M 13320000

- BASIN BOUNDARY
- RIVER OR CREEK
- ROADS
- RESERVATION BOUNDARY

NOTE:

HATCHERY FUNCTIONS INCLUDE INCUBATION AND EARLY REARING

0 5 10 20

SCALE IN MILES

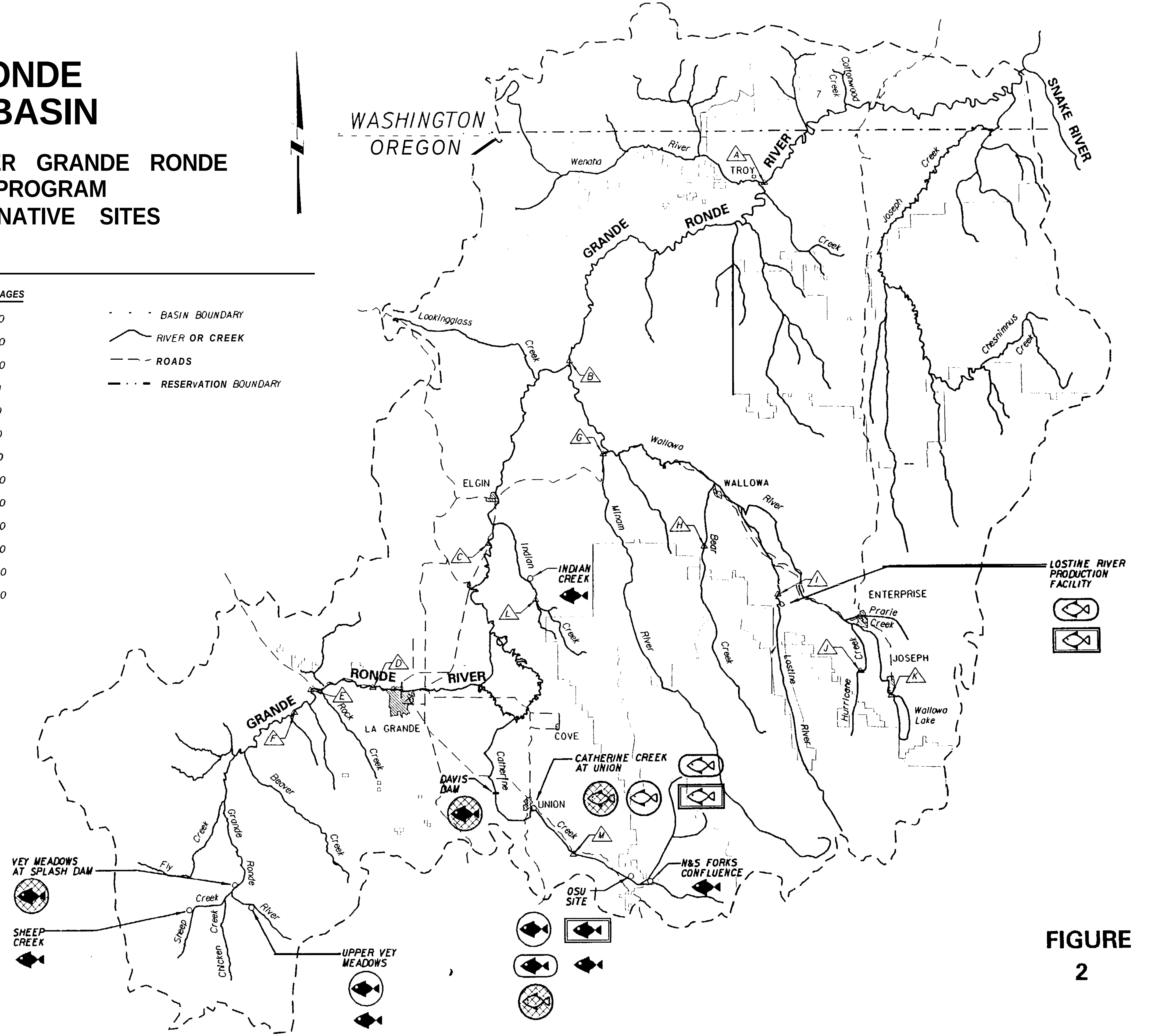
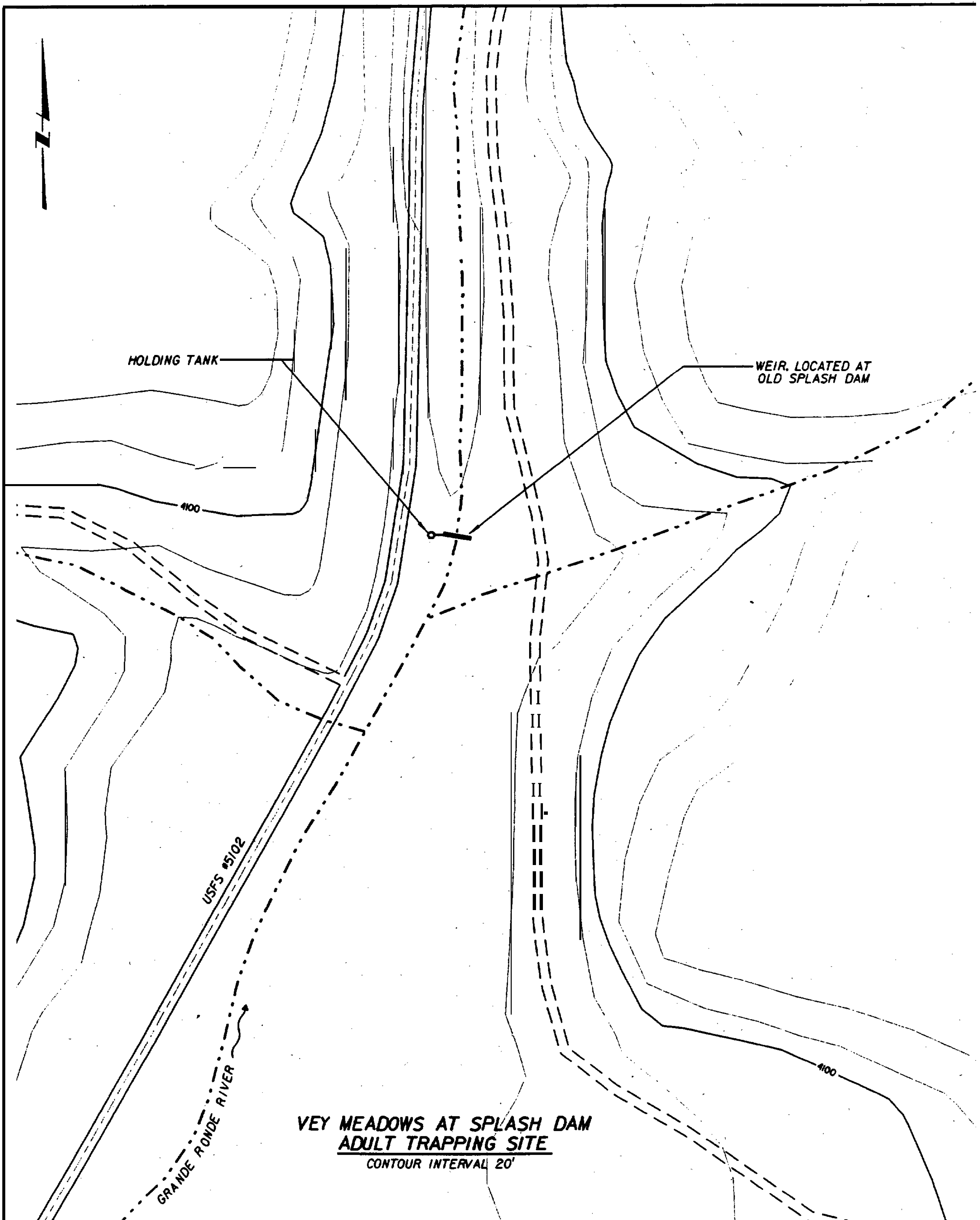
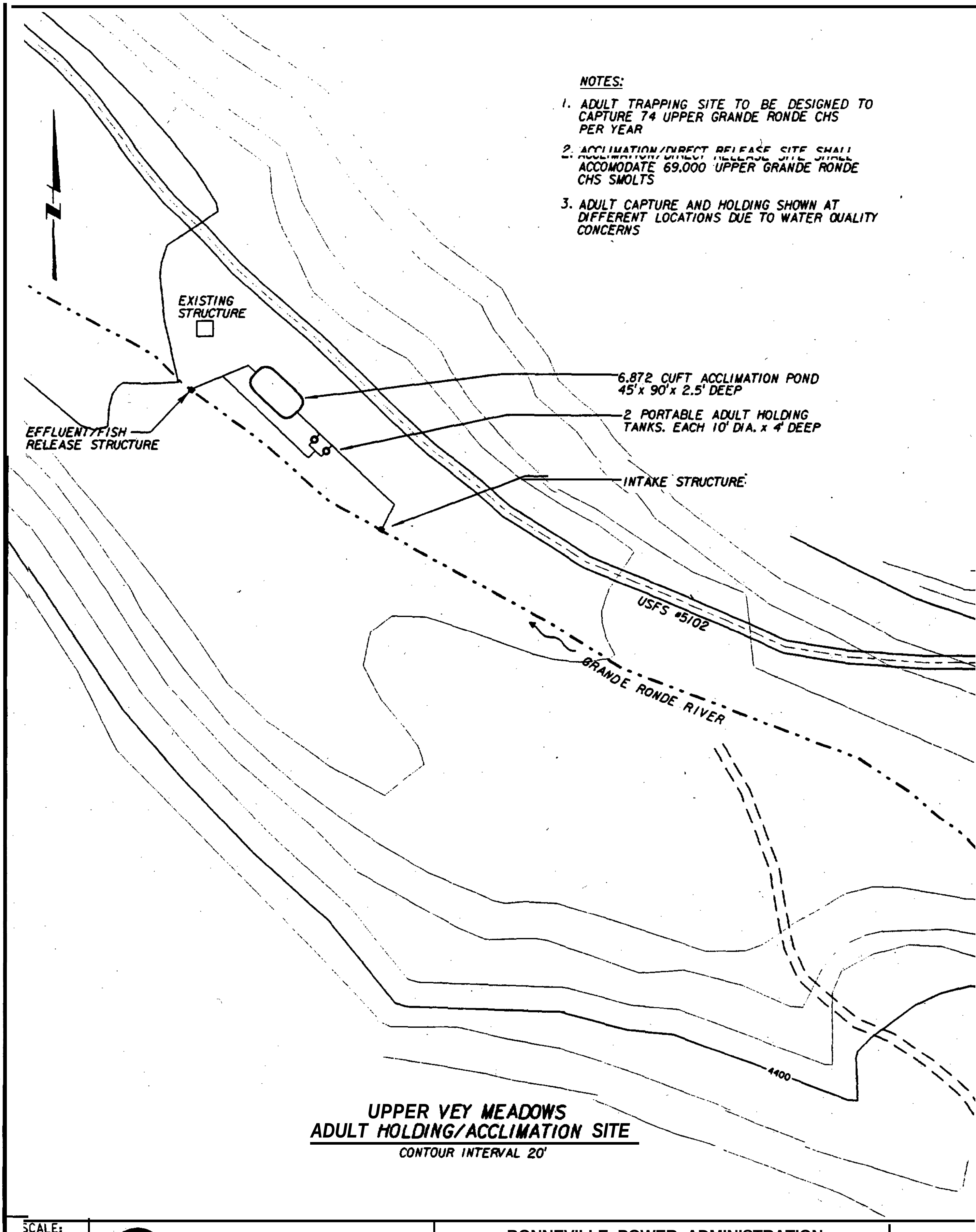


FIGURE 2

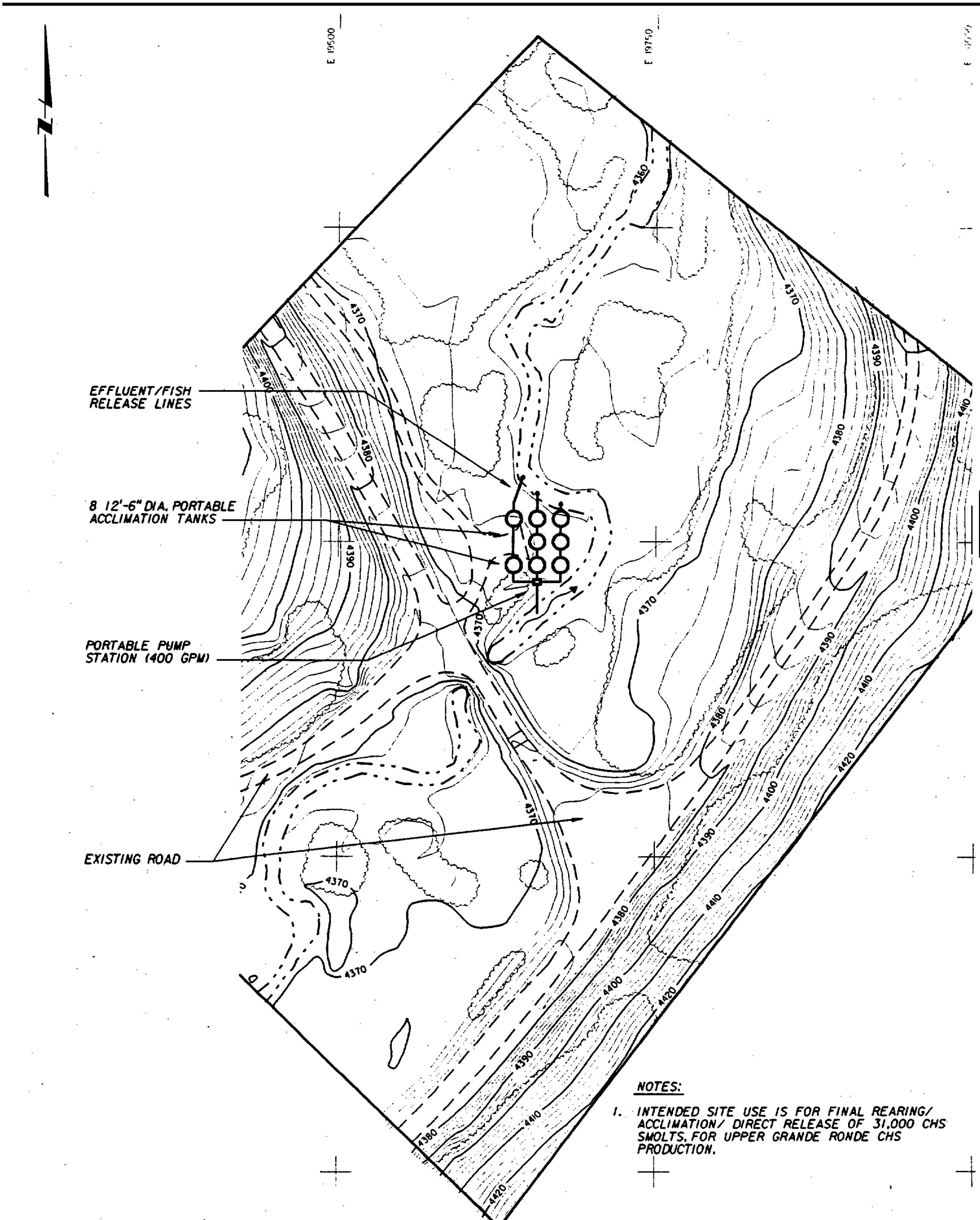


SCALE: 1"=200'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT VEY MEADOWS CHS ADULT TRAPPING. SITE	FIGURE: 3A

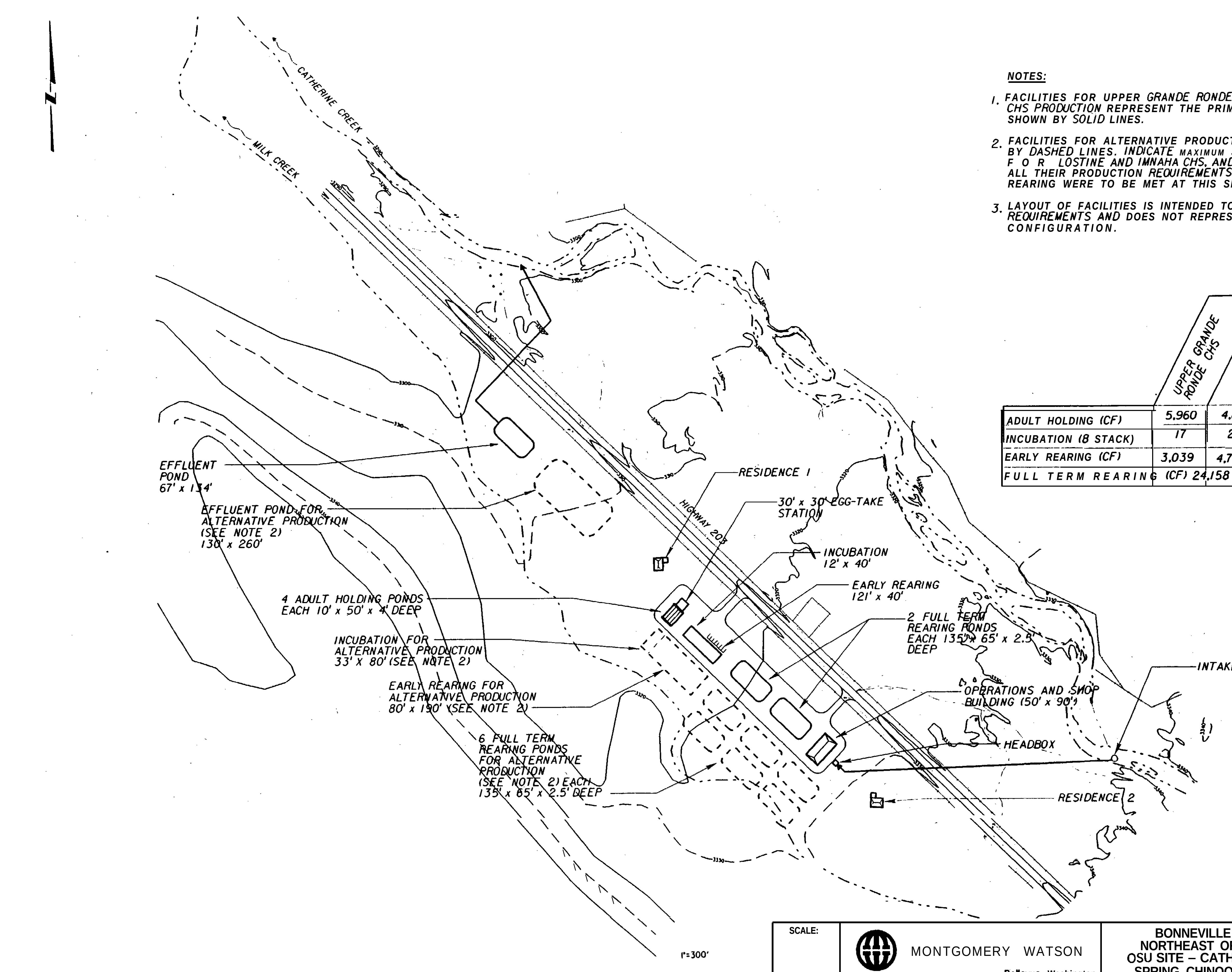


NOVEMBER, 1994

SCALE: 1"=200'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT VEY MEADOWS CHS ADULT HOLDING AND ACCLIMATION SITE	FIGURE: 3B



SCALE: 1"=100'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT SHEEP CREEK ACCLIMATION POND	FIGURE: 4



NOTES:

1. FACILITIES FOR UPPER GRANDE RONDE AND CATHERINE CREEK CHS PRODUCTION REPRESENT THE PRIMARY USE OF THIS SITE. SHOWN BY SOLID LINES.

2. FACILITIES FOR ALTERNATIVE PRODUCTION ARE PRESENTED BY DASHED LINES. INDICATE MAXIMUM SPACE REQUIREMENTS FOR LOSTINE AND IMNAHA CHS, AND GRANDE RONDE CHF IF ALL THEIR PRODUCTION REQUIREMENTS THROUGH FULL TERM REARING WERE TO BE MET AT THIS SITE.

3. LAYOUT OF FACILITIES IS INTENDED TO SHOW GENERAL SPACE REQUIREMENTS AND DOES NOT REPRESENT FINAL RECOMMENDED CONFIGURATION.

ALTERNATIVES

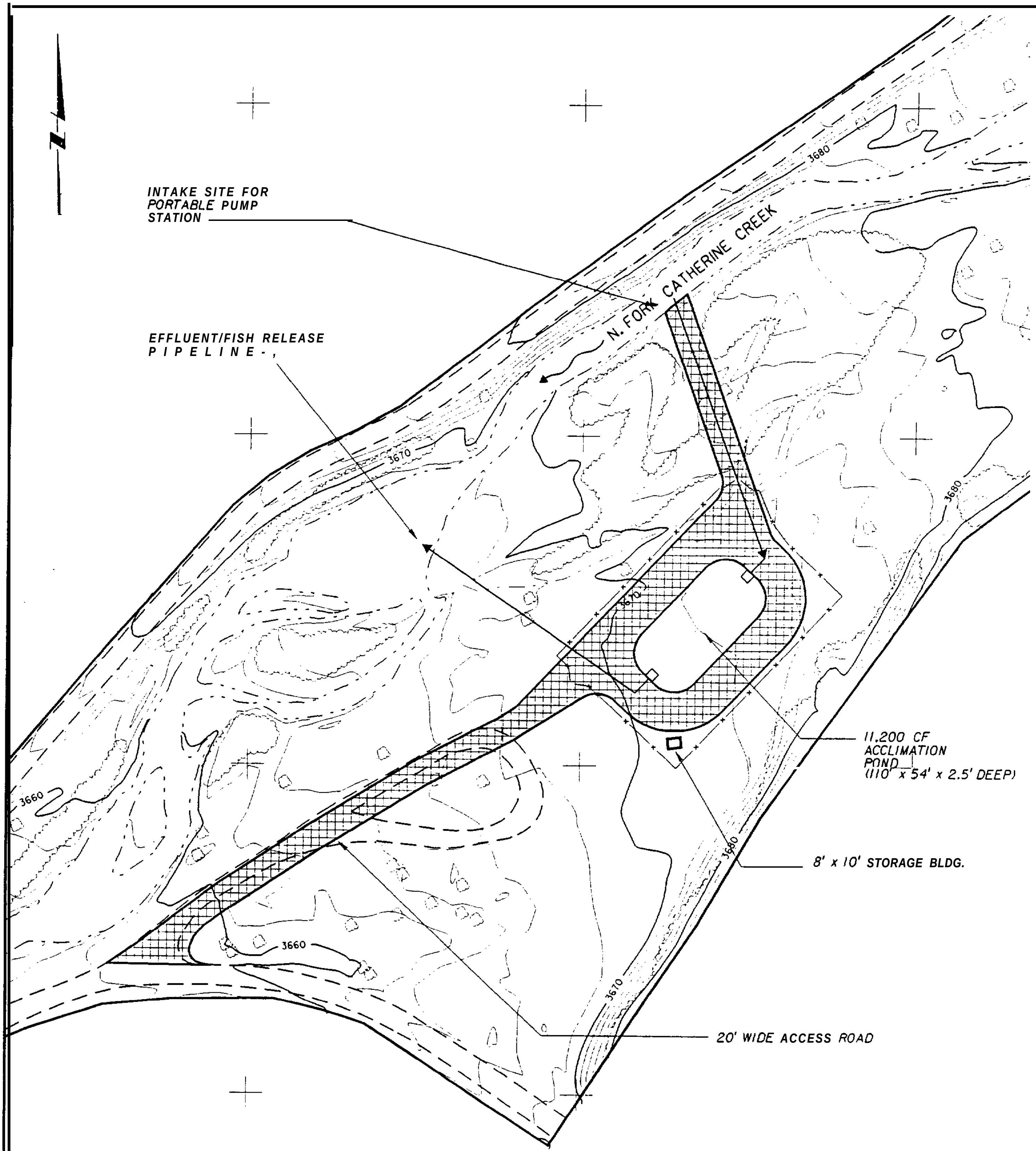
	UPPER GRANDE RONDE CHS	LOSTINE CHS	IMNAHA CHS	GRANDE RONDE CHF	ALTERNATIVE TOTAL
ADULT HOLDING (CF)	5,960	4,816	4,264	7000	16,000
INCUBATION (8 STACK)	17	29	26	50	105
EARLY REARING (CF)	3,039	4,790	4,298	9,892	18,980
FULL TERM REARING (CF)	24,158	42,051	23,368	38,644	104,113

SCALE:

MONTGOMERY WATSON
Bellevue, Washington

BONNEVILLE POWER ADMINISTRATION
NORTHEAST OREGON HATCHERY PROJECT
OSU SITE – CATHERINE CREEK
SPRING CHINOOK HATCHERY

FIGURE: 5



NOTES:

1. INTENDED SITE USE IS FOR FINAL REARING/ ACCLIMATION/ DIRECT RELEASE OF 112,000 CHS SMOLTS AT 15-20 LB.

NOVEMBER, 1994

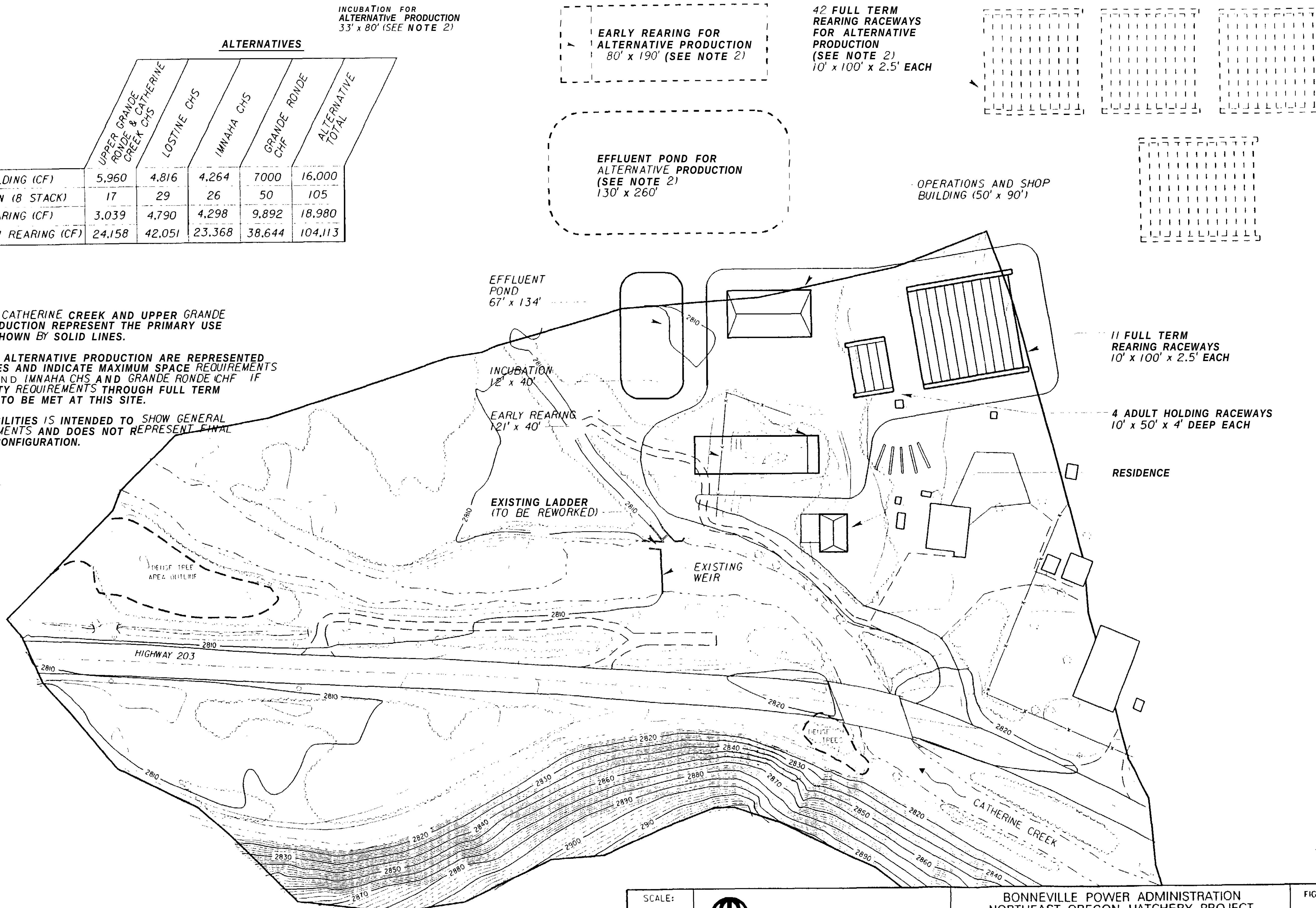
SCALE: 1"=100'	MONTGOMERY WATSON Bellevue, Washington	**BONNEVILLE POWER ADMINISTRATION** **NORTHEAST OREGON HATCHERY PROJECT** **CATHERINE CREEK – N&S FORKS CONFLUENCE** CHS **ACCLIMATION POND**	FIGURE: 6

ALTERNATIVES

	UPPER GRANDE RONDE & CATHERINE CREEK CHS	LOSTINE CHS	IMNAHA CHS	GRANDE RONDE CHF	ALTERNATIVE TOTAL
ADULT HOLDING (CF)	5,960	4,816	4,264	7000	16,000
INCUBATION (8 STACK)	17	29	26	50	105
EARLY REARING (CF)	3,039	4,790	4,298	9,892	18,980
FULL TERM REARING (CF)	24,158	42,051	23,368	38,644	104,113

NOTES:

1. FACILITIES FOR CATHERINE CREEK AND UPPER GRANDE RONDE CHS PRODUCTION REPRESENT THE PRIMARY USE OF THIS SITE. SHOWN BY SOLID LINES.
2. FACILITIES FOR ALTERNATIVE PRODUCTION ARE REPRESENTED BY DASHED LINES AND INDICATE MAXIMUM SPACE REQUIREMENTS FOR LOSTINE AND IMNAHA CHS AND GRANDE RONDE CHF IF ALL THE FACILITY REQUIREMENTS THROUGH FULL TERM REARING WERE TO BE MET AT THIS SITE.
3. LAYOUT OF FACILITIES IS INTENDED TO SHOW GENERAL SPACE REQUIREMENTS AND DOES NOT REPRESENT FINAL RECOMMENDED CONFIGURATION.



SCALE: 1"=100'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT CATHERINE CREEK AT UNION SPRING CHINOOK HATCHERY	FIGURE: 7

TABLE 24a

BONNEVILLE POWER ADMINISTRATION
VEY MEADOWS AT SPLASH DAM ADULT TRAPPING SITE
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	Ls			$2.500	$2.500
SITEWORK:					
Clearing and Grubbing	AC	1	$1,500	$750	
Access Road (gravel)	CY	100	$15	$1.500	
Cur	CY	100	$15	$1,500	
Fill	CY	100	$15	$1.500	
Erosion Control (rip-rap)	CY	30	$60	$1.800	
Fencing	LS	loo	$25	$2.500	$9.550
SHORT-TERM HOLDING SYSTEM					
10'dia FRP tank	EA	1	$2,000	$2,000	
Temporary Intake	LS	1	$4,000	$4,000	
Portable pump	EA	2	$2,000	$4.000	
Piping and appurtenances	LS		$5,000	$5,000	S15.000
TEMPORARY WEIR	LS		$12.000	$12,000	$12,000
ELECTRICAL	LS		$15,000	$15,000	$15.000
				SUBTOTAL	$54.050
				ESTIMATING CONTINGENCY (25%)	$13.513
				CONTRACTORS OH & PROFIT (20%)	$10.810
				TOTAL CONSTRUCTION COST (12/94)	$78,373

TABLE 24b

BONNEVILLE POWER ADMINISTRATION
UPPER VEY MEADOWS ADULT HOLDING AND ACCLIMATION SITE
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS			$10,000	$10.000
SITEWORK:					
Clearing and Grubbing	AC	1.20	$1,500	$1,800	
Landscaping	LS	1	$2,000	$2,000	
Access Road (gravel)	CY	300	$15	$4.500	
cut	CY	500	$15	$7.500	
Fill	CY	200	$15	$3,000	
Rock excavation (assumed)	CY	15	$70	$1,050	
Erosion Control (rip-rap)	CY	30	$60	$1.800	$21.650
YARD PIPING					
12" PVC	LF	250	$55	S13.750	
piping fittings	LS	1	$20,000	S20.000	
Pond Header	EA	1	S1.000	$1.000	
Pond Underdrain	LF	200	$20	$4,000	$38,750
ACCLIMATION POND					
Gravel	CY	100	$15	$1.500	
Asphaltic concrete liner	SY	500	$11	$5,500	
Birdnetting (on posts)	SF	4200	$4.00	$16,800	
Walkways	EA	2	$4.500	$9,000	
Met/outlet and misc.	LS	1	$7300	$7,500	$40,300
PORTABLE ADULT HOLDING TANKS IO' dia.	EA	2	$2,000	$2,000	$2,000
PORTABLE PUMP SYSTEMS	EA	2	$8,000	$16,000	S16.000
RIVER STRUCTURES					
Intake st.ructure	LS	1	$8,000	56.000	
Outlet structure	LS	1	$3,000	$2,000	
Dewatering	LS	1	$4,000	$3,500	$11.500
ELECTRICAL/INSTRUMENTATION (trailer and pump power)	LS	1	$15,000	$15,000	$15,000
				SUBTOTAL	$155.200
				ESTIMATING CONTINGENCY (25%)	$38,800
				CONTRACTORS OH & PROFIT (20%)	$31,040
				TOTAL CONSTRUCTION COST (12/94)	$225,040

TABLE 25

BONNEVILLE POWER ADMINISTRATION
SHEEP CREEK ACCLIMATION SITE
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS			$2,000	$2,000
SITEWORK:					
Clearing and Grubbing	AC	0.50	$1,500	$750	
cut	CY	100	$15	$1.500	
Fill	CY	100	$15	$1.500	
Emsion Control (rip-rap)	CY	15	$60	$900	$4.650
YARD PIPING	LS	1	$5,000	$5,000	$5,000
ACCLIMATION TANKAGE					
12' Dia FRP Tanks	EA	8	$2,100	$16,800	$16,800
PORTABLE PUMP SYSTEMS	EA	2	$4,000	$8,000	$8,000
RIVER STRUCTURES					
Intake structure	LS	1	$5,000	$5,000	
Outlet structure	LS	1	$2,000	$2,000	
Dewatering	LS	1	$2,000	$2,000	$9,000
ELECTRICAL/INSTRUMENTATION (trailer power)	LS	1	$7,500	$7,500	$7,500
				SUBTOTAL	$52,950
				ESTIMATING CONTINGENCY (25%)	$13,238
				CONTRACTORS OH & PROFIT (20%)	$10,590
				TOTAL CONSTRUCTION COST (12/94)	**$76,778**

TABLE 26

BONNEVILLE POWER ADMINISTRATION
CATHERINE CREEK AT OSU HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS	1	$70.000	$70,000	$70,000
SITEWORK:					
Cleating and Grubbing	AC	5.00	$1,500	$7500	
Landscaping	Ls	1	$5.000	$5.000	
Gravel surfacing (all driving surfaces)	CY	2,000	$15	$30,000	
Excavation - deposit on site	CY	3.400	$12	$40,800	
Engineered Fill	CY	400	$20	$8,000	
Erosion Control (rip-rap)	CY	200	$60	$12,000	
Fencing	LF	2.100	$18	$37.800	
Gates	EA	5	$600	$3.000	$144,100
ADULT HOLDING RACEWAYS					
Concrete	CY	165	$450	$74,250	
Slide Gates	EA	4	$8,000	$32,000	
Inlet DIFFUSERS	SF	16	$75	$1,200	
Outlet Drain Plates	EA	4	$75	$300	
Outlet Pipe Winch & standpipe	EA	4	$800	$3200	
Handrail	LF	250	$22	$5500	
Piping and valves	LS	1	$30,000	$30,000	$ 146,450
EGG-TAKE STATION	SF	900	$120	$108,000	$108,000
HATCHERY BUILDING					
bldg is one floor incl. everything w/in walls except:	SF	5,320	$55	$292,600	
Incubators, 8 stack	EA	17	$950	$16,150	
Rearing troughs, 500 gal ea.	EA	50	$1,600	$80,000	$388,750
HEADTANK					
Cont. and misc. metals	CY	50	$475	$23.750	
piping, valves, weir, railing, and misc.	LS	1	$20,000	$20,000	$43,750
YARD PIPING	LS	1	$400,000	$400,ooo	$400,000
OPERATIONS BUILDING building is one floor w/ feed room, garage, offices, lab. incl. everything w/in walls	SF	4,500	$68	$306,000	$306,000
RESIDENCES					
two 3 bdr houses, 1400 sf living area	SF	2,800	$62	$173,600	
two 400 sf garages	SF	800	$38	$30,400	$204,000
REARING PONDS (2)					
Earthwork	covered above under "sitework"				
Underdrain piping system	LF	680	$20	$13,600	
Subgrade	SY	2,000	$5	$10,000	

TABLE 26

BONNEVILLE POWER ADMINISTRATION
CATHERINE CREEK AT OSU HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Subgrade	SY	2,000	$5	$10,000	
Asphalt Lining	SY	2,000	$10	$20,000	
Birdnetting (on posts)	SF	18,000	$3	$54,000	
Hydraulic structures	LS	2	$10,000	$20.000	$117.600
EFFLUENT POND					
Earthwork	covered above under "sitework"				
Underdrain piping system	LF	340	$20	$6.800	
Subgrade	SY	l.000	$5	$5.000	
Asphalt Lining	SY	1,000	$10	$10,000	
Hydraulic structures	LS	1	$8,000	$8,000	$29,800
CARCASS DISPOSAL	LS	1	$30,000	$30,000	$30.000
INTAKE STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	50	$475	$23.750	
Misc. metals	LS	1	$4,500	$4.500	
Wedgewire screen	SF	350	$90	$3 1500	
Sluice gate	EA	1	$3,000	$3,000	
Automatic screen cleaner	EA	1	$70,000	$70,000	
Baffles	LS	1	$5,000	$5,000	
Stoplogs	LS	1	$9,000	$9,000	
Pipe specials	LS	1	$3,000	$3,000	
Dewatering	LS	1	$12,000	$12,000	$161,750
EFFLUENT STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	40	$475	$19,000	
Misc. metals	LS	1	$2,000	$2,000	
Dewatering	LS	1	$5,000	$5,000	$26,000
POTABLE WELL WATER SYSTEM	LS	1	$10,000	$10,000	$10,000
UTILITY WATER PUMP STATION	LS	1	$18,000	$18,000	$18,000
ELECTRICAL (7% of subtotal)	LS	1	$197,000	$167,000	$167,000
INSTRUMENTATION (0.5% of subtotal)	LS	1	$14,000	$12,000	$12,000
				SUBTOTAL	$2,383,200
				ESTIMATING CONTINGENCY (25%)	$595,800
				CONTRACTORS OH & PROFIT (20%)	$476,640
				TOTAL CONSTRUCTION COST (12/94)	$3,455,640

TABLE 27

BONNEVILLE POWER ADMINISTRATION
CATHERINE CREEK N&S FORK CONFLUENCE ACCLIMATION FACILITY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS			$15,000	$15,000
SITEWORK:					
Clearing and Grubbing	AC	2	$1,500	$2,250	
Landscaping	LS	1	$2,000	$2,000	
Access Road (gravel)	CY	450	$15	$6,750	
cut	CY	500	$15	$7,500	
Fill	CY	200	$15	$3,000	
Rock excavation (assumed)	CY	15	$70	$1,050	
Erosion Control (rip-rap)	CY	30	$60	$1,800	
Fencing	LF	600	$18	$10,800	
Gates	EA	3	$600	$1,800	$36,950
YARD PIPING					
14" Ductile Iron	LF	450	$55	$24,750	
Pond Header	EA	1	$1,000	$1,000	
Pond Underdrain	LF	300	$20	$6,000	$31,750
ACCLIMATION POND					
Gravel	CY	850	$15	$12,750	
Asphaltic concrete liner	SY	700	$11	$7,700	
Birdnetting (on posts)	SF	6,000	$4.00	$24,000	
Walkways	EA	2	$4,500	$9,000	
Inlet/outlet and misc.	LS	1	15,000	$15,000	$68,450
PORTABLE PUMP SYSTEMS	EA	3	6,000	$12,000	$12,000
RIVER STRUCTURES					
Intake structure	LS	1	s10,000	$10,000	
Outlet structure	LS	1	$6,000	$6,000	
Dewatering	LS	1	s10,000	s10,000	$26,000
STORAGE BUILDING	SF	80	$100	$8,000	$8,000
ELECTRICAL/INSTRUMENTATION (trailer and pump power)	LS	1	$15,000	$15,000	$15,000
				SUBTOTAL	$213,150
				ESTIMATING CONTINGENCY (25%)	$53,288
				CONTRACTORS OH & PROFIT (20%)	$42,630
				TOTAL CONSTRUCTION COST (12/94)	**$309,068**

TABLE 28

BONNEVILLE POWER ADMINISTRATION
CATHERINE CREEK AT UNION HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS	1	$80,000	$80,000	$80,000
SITEWORK:					
Clearing and Grubbing	AC	3.00	$1,500	$4,500	
Landscaping	LS	1	$5,000	$5,000	
Gravel surfacing (all driving surfaces)	CY	1,500	$15	$22,500	
Excavation - deposit on site	CY	2,000	$12	$24,000	
Engineered Fill	CY	400	$20	$8,000	
Erosion Control (rip-zap)	CY	200	$60	$12,000	
Fencing	LF	1,400	$18	$25,200	
Gates	EA	4	$600	$2,400	$103,600
ADULT HOLDING RACEWAYS					
Concrete	CY	175	$450	$78,750	
Slide Gates	EA	4	$8,000	$32,000	
Inlet Diffusers	SF	16	$75	$1,200	
Outlet Drain Plates	EA	4	$75	$300	
Outlet Pipe Winch & standpipe	EA	4	$800	$3,200	
Handrail	LF	180	$22	$3,960	
Piping and valves	LS	1	$25,000	$25,000	$144,410
FULL TERM REARING RACEWAYS					
Concrete	CY	680	$450	$306,000	
Slide Gates	EA	11	$8,000	$88,000	
Inlet Diffusers	SF	44	$75	$3,300	
Outlet Drain Plates	EA	11	$75	$825	
Outlet Pipe Winch & standpipe	EA	11	$800	$8,800	
Handrail	LF	420	$22	$9,240	
Piping and valves	LS	1	$50,000	$50,000	$466,165
HATCHERY BUILDING					
bldg is one floor incl. everything w/in walls except:	SF	5,320	$55	$292,600	
Incubators, 8 stack	EA	17	$950	$16,150	
Rearing troughs, 500 gal ea.	EA	50	$1,600	$80,000	$388,750
HEADTANK					
Conc. and misc. metals	CY	50	$475	$23,750	
piping, valves, weir, railing, and misc.	LS	1	$20,000	$20,000	$43,750
YARD PIPING	LS	1	$200,000	$200,000	$200,000
OPERATIONS BUILDING building is one floor w/ feed room, garage, offices. lab. incl. everything w/in walls	SF	4,500	$68	$306,000	$306,000
RESIDENCES					
two 3 bdr houses, 1400 sf living area	SF	2,800	$62	$173,600	
two 400 sf garages	SF	800	$38	$30,400	$204,000
EFFLUENT POND					
Earthwork	covered above under "sitework"				
Underdrain piping system	LF	340	$20	$6,800	

TABLE 28

BONNEVILLE POWER ADMINISTRATION
CATHERINE CREEK AT UNION HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Subgrade	SY	1,000	$5	$5,000	
Asphalt Lining	SY	1,000	$10	$10,000	
Hydraulic structures	LS	1	$8,000	$8,000	$29,800
CARCASS DISPOSAL	LS	1	$30,000	$30,000	$30.000
INTAKE STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	50	$475	$23,750	
Misc. metals	LS	1	$4,500	$4,500	
Wedgewire screen	SF	350	$90	$31,500	
Sluice gate	EA	I	$3,000	$3,000	
Automatic screen cleaner	EA	1	$70,000	$70,000	
Baffles	LS	1	$5,000	$5,000	
Stoplogs	LS	1	$9,000	$9,000	
Pipe specials	LS	1	$3,000	$3,000	
Dewatexing	LS	1	$12,000	$12,000	$161,750
EFFLUENT STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	40	$475	$19,000	
Misc. metals	LS	1	$2,000	$2,000	
Dewatering	LS	1	$5,000	$5,000	$26,000
POTABLE WELL WATER SYSTEM	LS	1	$10,000	$10,000	$10,000
UTILITY WATER PUMP STATION	LS	1	$18,000	$18,000	$18,000
RIVER INTAKE PUMP STATION					
Pump station slab & encase	CY	55	$250	$13,750	
pumps	EA	4	$25,000	$100.000	
Flow meter w/vault	EA	1	$7,500	$7,500	
Valves	LS	1	$15,000	$15,000	
piping	EA	1	$15,000	$15,000	
Protective Coatings	EA	1	$5,000	$5,000 .	
pump Panel	EA	1	$45,000	$45,000	
Controls (basic)	EA	1	$7,500	$7,500	$208,750
ELECTRICAL (7% of subtotal)	LS	1	$197,000	$183,000	$183,000
INSTRUMENTATION (0.5% of subtotal)	LS	1	$14,000	$13,000	$13,000
				SUBTOTAL	$2,616,975
				ESTIMATING CONTINGENCY (25%)	$654,244
				CONTRACTORS OH & PROFIT (20%)	$523,395
				TOTAL CONSTRUCTION COST (12/94)	$3,194,614

SITE LAYOUTS FOR WALLOWA - LOSTINE

SPRING CHINOOK PROGRAM

INTRODUCTION

This section presents the site layouts of the facilities required for the Wallowa and Lostine River basins Spring Chinook Program. These facilities and the preferred / alternative sites were listed in Table 15. Preferred sites for all production phases are located within the Lostine River subbasin (Figure 8). One final rearing / acclimation / direct release site is designated for Bear Creek, which is tributary to the Wallowa River near the town of Wallowa, downstream from the Lostine River's confluence with the Wallowa.

It is also planned to use some current release sites (approximately 7) on the upper Lostine River road for direct release of spring chinook fry. No conceptual design for these 7 sites was required.

In the time period since initial development of these site layouts, the ownership of the Stratheam Ranch has changed hands, and no agreement to study the property as a potential production facility has been reached with the new owners. An alternative site to replace the Strathearn Ranch for its intended uses is located adjacent to the Lostine River at the ODF&W Bighorn Sheep Range, approximately 1 mile upstream from the Stratheam Ranch. One change to the program caused by moving to the Bighorn Sheep Range is the location of adult capture facilities: the Cross Valley Diversion (Clearwater Ditch) on the lower Lostine River was identified as the alternative to the Strathearn Ranch for adult capture.

Conceptual layouts at the Bighorn Sheep Range (and the Cross Valley Diversion) are not yet available, however, they will include the same basic facilities shown on the layouts for the Stratheam Ranch.

MAXIMUM FACILITY REQUIREMENTS

Table 29 lists the maximum facility requirements for water supply (gpm) and volume (cf) required for the Wallowa - Lostine program. The proposed layout to meet these requirements is also listed. The following drawings present a proposed site layout, emphasizing the ability of the preferred site to meet the space requirements. The final layout of the facilities at a site may differ from that shown in these drawings.

TABLE 29

MAXIMUM FACILITY REQUIREMENTS

WALLOWA - LOSTINE SPRING CHINOOK

Facility	Site	Water Supply (gpm)	Volume (cuft)	Proposed Layout
Incubation	Stratheam Ranch (a)	172	963,900 eggs	29 stacks of 8 trays/stack
Early Rearing	Stratheam Ranch (a)	655	1,558	25 fry troughs each 2O'x2.5'x1.25' deep
Adult Holding/ Spawning	Strathearn Ranch (a)	477	3,200	adult raceway
Full Term Rearing	Strathearn Ranch (a)	3,447	34,956	17 raceways or 2 ponds
Final Rearing	Stratheam Ranch (a) Bear Creek	4,310 351	51,276 2,789	side channel portable tank

(a) Probable that alternative site at ODF&W Bighorn Sheep Range will need to be developed.

PRODUCTION TIMING AND TEMPERATURE CONSIDERATIONS

The temperature data for the Wallowa-Lostine Spring Chinook program is based on the temperature from the Stratheam Ranch site. Temperature criteria consideration for the site based on the use of surface water for all phases is presented in the following table for comparison of sites. During August and September, the surface water is slightly warmer than the temperature criteria for adult holding. Temperature of groundwater at the site is not yet available. A small amount of heating and chilling is needed for incubation if surface water is used. Due to the relatively small amount of water used, temperature adjustment for incubation is generally not a significant problem.

Based on the production goals and growth rates shown on Table 5, four growth models were simulated (Table 30).

TABLE 30

INFLUENCE OF WATER SOURCE ON GROWTH RATE

WALLOWA-LOSTINE SPRING CHINOOK

Water Source	Actual Release Date @ lS/lb	Actual Release Date @ 20/lb	Desired Release Date	Comments
GW for Incubation and Early Rearing SW for Rearing	Need groundwater temperature	Need groundwater temperature	March - May 15	Probably too rapid growth
SW for Incubation, Early Rearing, and Rearing	March 2	October 13	March - May 15	Simulation of surface water temperatures produces acceptable release date.

GW = groundwater
SW = surface water or groundwater adjusted to the local surface water temperature

The use of groundwater for incubation and early rearing results in too rapid growth of spring chinook. Disinfected surface water or groundwater adjusted to the local surface water results is much better timing. Timing problems are especially critical for the 20/lb fish. Groundwater can be used to cool the water during the summer to help adjust production timing.

Table 31 shows relative heating and cooling requirements at the site.

TABLE 31

COMPARISON OF ACTUAL TEMPERATURES, TEMPERATURE CRITERIA, AND DEGREE OF REQUIRED HEATING OR COOLING

Temperature Criteria - Spring Chinook - Lostine River

	Actual Temperature (°F)			Temperature Criteria (°F)				Required ΔT (°F)		
Month	10 % of Daily Min.	Mean of Daily Average	75 % of Daily Max.	Max Adult Holding	Min Incub	Max Incub	Max Rearing	Adult Holding	Incub	Rearing
Oct	37.6	43.6	52.0							
Nov	33.2	36.8	40.5							
Dec	31.8	34.0	36.5							
Jan	31.6	34.4	37.2							
Feb	33.6	37.2	42.1							
Mar	34.3	39.2	45.3							
Apr	35.6	41.2	47.9	63						
May	37.4	41.8	46.8	63						
Jun	38.0	43.2	49.1	63						
Jul	42.5	50.5	57.0	63						
Aug	49.6	55.1	61.9	60	38	60		-1.9	-1.9	
Sep	45.0	52.1	60.6	60	38	60		-0.6	-0.6	
Oct	37.6	43.6	52.0		38	60			+0.4	
Nov	33.2	36.8	40.5		38	60	63		+4.8	
Dec	31.8	34.0	36.5		38	60	63		+6.2	
Jan	31.6	34.4	37.2				63			
Feb	33.6	37.2	42.1				63			
Mar	34.3	39.2	45.3				63			
Apr	35.6	41.2	47.9				63			
May	37.4	41.8	46.8				63			
Jun	38.0	43.2	49.1				63			
Jul	42.5	50.5	57.0				63			
Aug	49.6	55.1	61.9				63			
Sep	45.0	52.1	60.6				63			
Oct	37.6	43.6	52.0				63			
Nov	33.2	36.8	40.5				63			
Dec	31.8	34.0	36.5				63			
Jan	31.6	34.4	37.2				63			
Feb	33.6	37.2	42.1				63			
Mar	34.3	39.2	45.3				63			
Apr	35.6	41.2	47.9				63			
May	37.4	41.8	46.8				63			
Jun	38.0	43.2	49.1							
Jul	42.5	50.5	57.0							
Aug	49.6	55.1	61.9							
Sep	45.0	52.1	60.6							

TABLE 32

REQUIRED FLOWS
STRATHEARN REACH

		Adult Holding Surface Water Flow (gpm)	Incubation Groundwater Flow (gpm)	Early Rearing Groundwater Flow (gpm)	Rearing Surface Water Flow (gpm)	Total Surface Flow (gpm)	Total GW Flow (gpm)	Total Water Flow (gpm)
Week	Date							
0	1-Jan	0		536	1908	1908	536	2443
1	8-Jan	0		565	1883	1883	565	2447
2	15-Jan	0		594	1876	1876	594	2469
3	22-Jan	0		624	1947	1947	624	2570
4	29-Jan	0		654	1981	1981	654	2635
5	5-Feb	0		686	2087	2087	686	2773
6	12-Feb	0		718	2191	2191	718	2909
7	19-Feb	0		752	2216	2216	752	2968
8	26-Feb	0		790	2206	2206	790	2996
9	5-Mar	0		826		0	826	826
10	12-Mar	0		867		0	867	867
11	19-Mar	0		911		0	911	911
12	26-Mar	0		963		0	963	963
13	2-Apr	0		1019		0	1019	1019
14	9-Apr	35			518	553	0	553
15	16-Apr	80			569	649	0	649
16	23-Apr	115			576	691	0	691
17	30-Apr	166			618	783	0	783
18	7-May	180			619	799	0	799
19	14-May	242			679	921	0	921
20	21-May	234			681	915	0	915
21	28-May	252			737	989	0	989
22	4-Jun	254			769	1022	0	1022
23	11-Jun	243			787	1030	0	1030
24	18-Jun	276			884	1161	0	1161
25	25-Jun	289			959	1249	0	1249
26	2-Jul	341			1075	1416	0	1416
27	9-Jul	390			1287	1676	0	1676
28	16-Jul	426			1502	1928	0	1928
29	23-Jul	477			1804	2280	0	2280
30	30-Jul	444			2074	2518	0	2518
31	6-Aug	431	113		2277	2707	113	2820
32	13-Aug	392	113		2412	2804	113	2916
33	20-Aug	337	113		2582	2919	113	3031
34	27-Aug	290	113		2674	2964	113	3077
35	3-Sep	243	113		2858	3101	113	3214
36	10-Sep	176	113		2767	2943	113	3056
37	17-Sep	79	113		2635	2715	113	2827
38	24-Sep	0	113		2874	2874	113	2987
39	1-Oct	0	113		2551	2551	113	2664
40	8-Oct	0	113		2436	2436	113	2548
41	15-Oct	0	113		2349	2349	113	2462
42	22-Oct	0	113		2281	2281	113	2394
43	29-Oct	0	113		2025	2025	113	2137
44	5-Nov	0	113		2153	2153	113	2265
45	12-Nov	0	113		2070	2070	113	2183
46	19-Nov	0	113		1940	1940	113	2053
47	26-Nov	0		378	1896	1896	378	2274
48	3-Dec	0		403	2015	2015	403	2418
49	10-Dec	0		428	1850	1850	428	2278
50	17-Dec	0		454	1803	1803	454	2257
51	24-Dec	0		481	1826	1826	481	2307
52	31-Dec			508	1813	1813	508	2321
	Maximum	477	113	1019	2874	3101	1019	3214

SITE LAYOUTS

Wallowa - Lostine site layouts are depicted on the following figures.

PRELIMINARY COST ESTIMATES

Preliminary cost estimates (+50%, -35%) for the Wallowa - Lostine program are shown on Tables 33 through 35.

GRANDE RONDE DRAINAGE BASIN

WALLOWA-LOSTINE SPRING CHINOOK PROGRAM
PREFERRED AND ALTERNATIVE SITES

LEGEND

FACILITY TYPES:

PREFERRED SITES;

- ADULT CAPTURE SITE
- ADULT HOLDING SITE
- HATCHERY SITE
- FULL TERM REARING SITE
- FINAL REARING/ACCLIMATION/ DIRECT RELEASE SITE

ALTERNATIVE SITES:

- ADULT CAPTURE SITE
- ADULT HOLDING SITE
- HATCHERY SITE
- FULL TERM REARING SITE
- FINAL REARING/ACCLIMATION/ DIRECT RELEASE SITE

STREAMFLOW GAGES

- A 13333000
- B 13332500
- C 13323500
- D 13319000
- E 13318800
- F 13318500
- G 13331500
- H 13330500
- I 13330000
- J 13329500
- K 13327500
- L 13323600
- M 13320000

- BASIN BOUNDARY
- RIVER OR CREEK
- ROADS
- RESERVATION BOUNDARY

NOTES:

1. HATCHERY FUNCTIONS INCLUDE INCUBATION AND EARLY REARING.
2. WALLOWA HATCHERY IS AN ALTERNATIVE FOR INCUBATION ONLY.
3. CAPTURE IS AT CROSS VALLEY DIVERSION IF PRODUCTION FACILITY IS LOCATED AT ODF&W BIGHORN SHEEP RANGE.

0 5 10 20

SCALE IN MILES

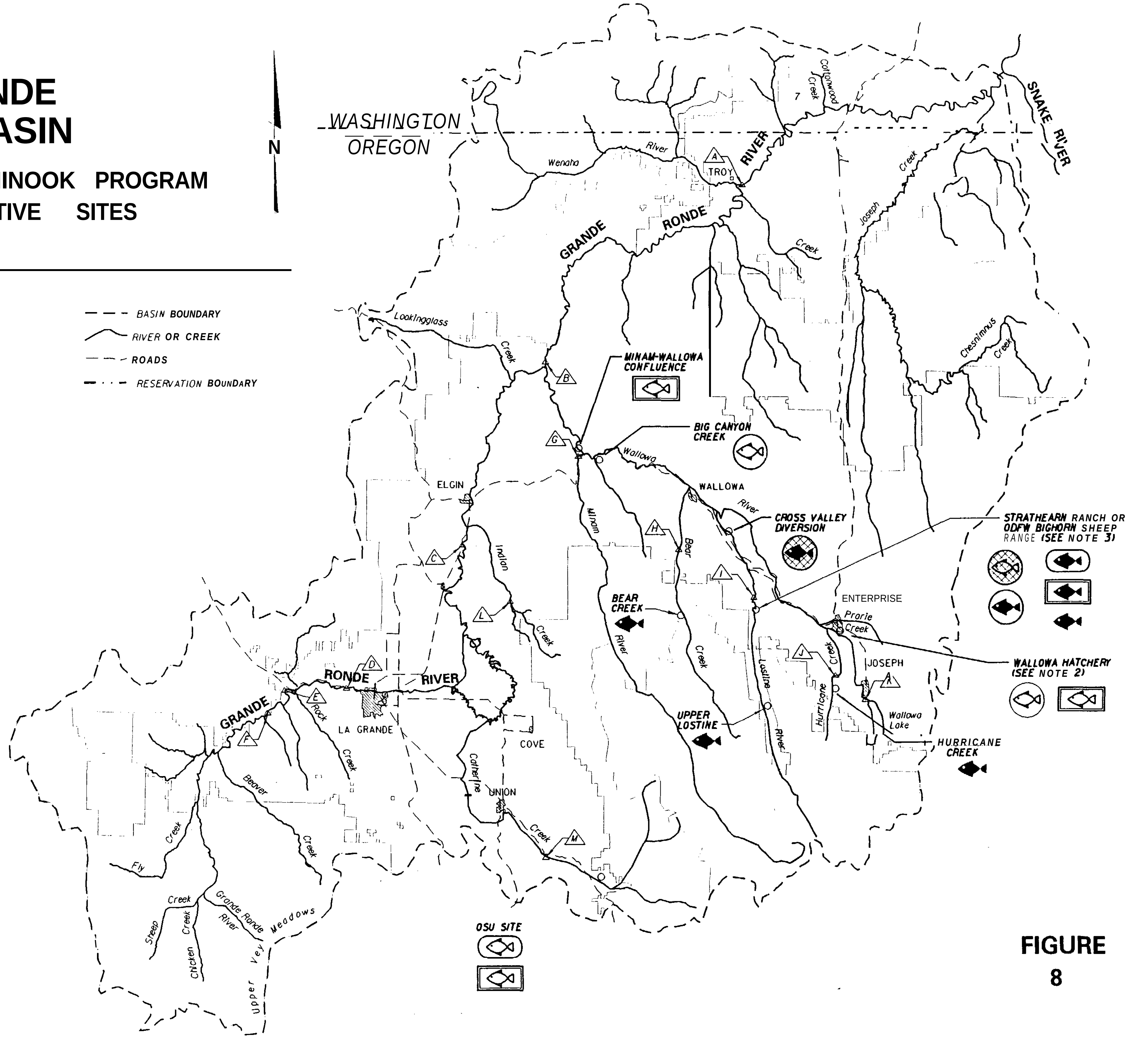
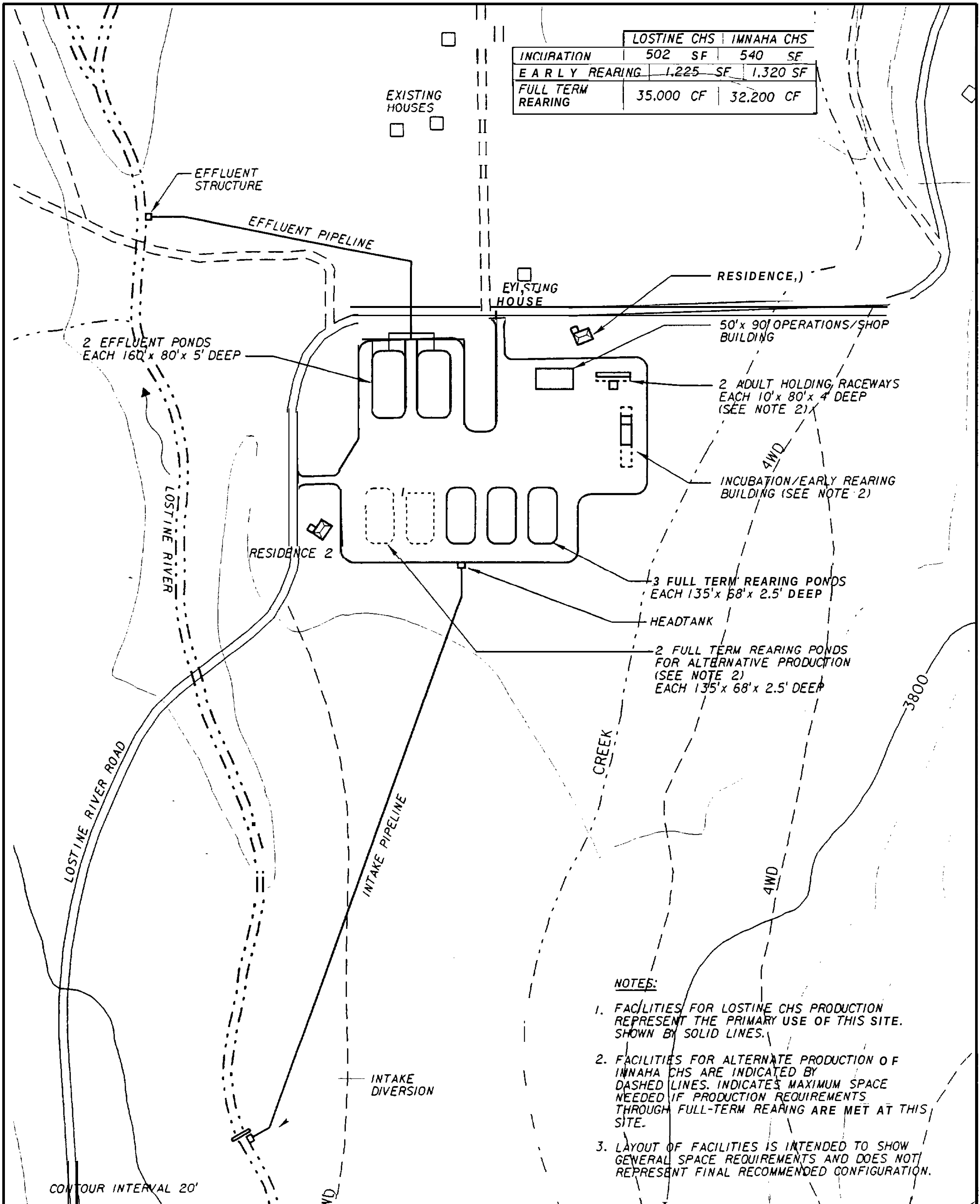


FIGURE 8



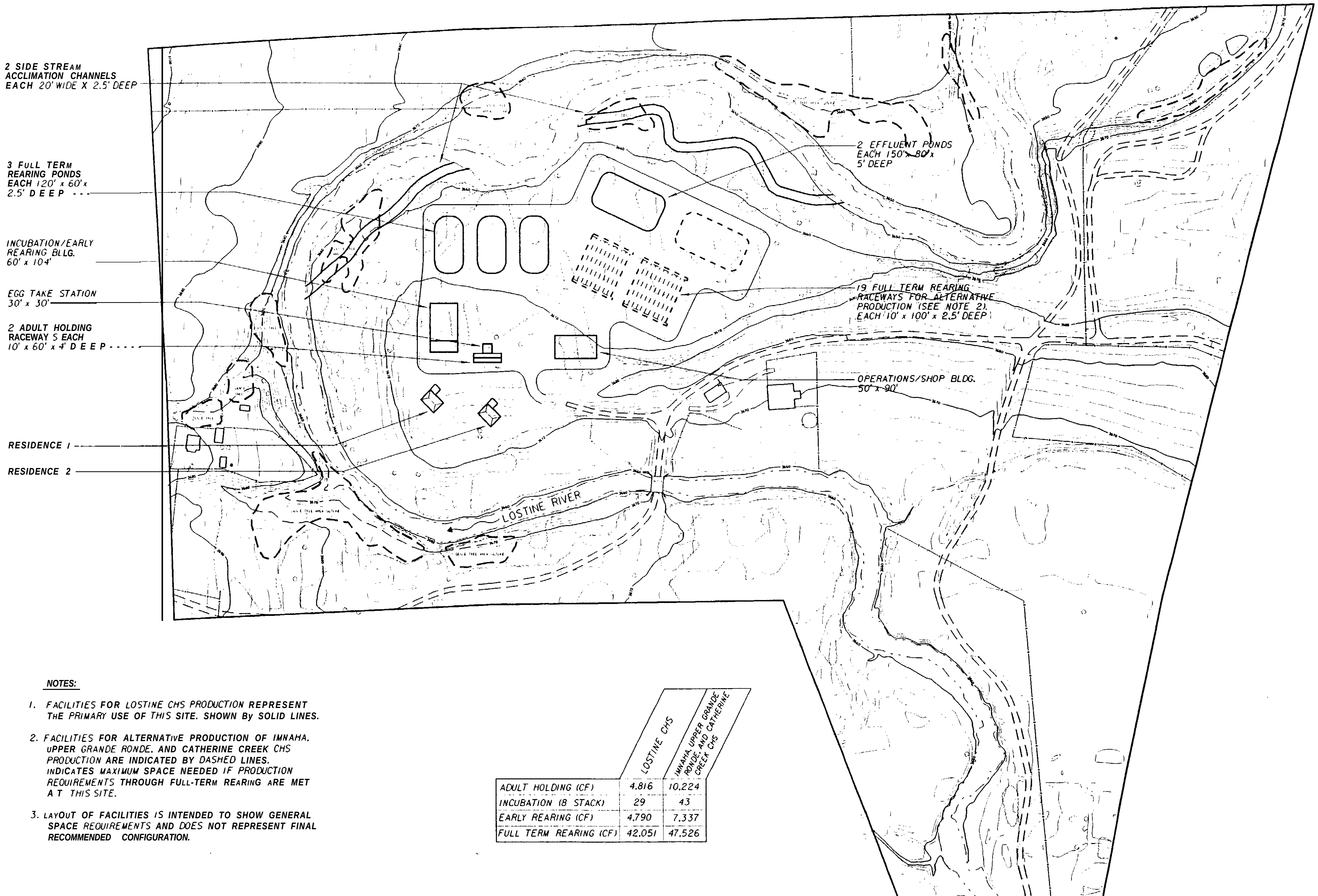
	LOSTINE CHS	IMNAHA CHS
INCUBATION	502 SF	540 SF
EARLY REARING	1,225 SF	1,320 SF
FULL TERM REARING	35,000 CF	32,200 CF

NOTES:

1. FACILITIES FOR LOSTINE CHS PRODUCTION REPRESENT THE PRIMARY USE OF THIS SITE. SHOWN BY SOLID LINES.
2. FACILITIES FOR ALTERNATE PRODUCTION OF IMNAHA CHS ARE INDICATED BY DASHED LINES. INDICATES MAXIMUM SPACE NEEDED IF PRODUCTION REQUIREMENTS THROUGH FULL-TERM REARING ARE MET AT THIS SITE.
3. LAYOUT OF FACILITIES IS INTENDED TO SHOW GENERAL SPACE REQUIREMENTS AND DOES NOT REPRESENT FINAL RECOMMENDED CONFIGURATION.

NOVEMBER 1994

SCALE: 1"=300'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT ODFW BIGHORN SHEEP RANGE – LOSTINE RIVER SPRING CHINOOK HATCHERY	FIGURE: 9



NOTES:

1. FACILITIES FOR LOSTINE CHS PRODUCTION REPRESENT THE PRIMARY USE OF THIS SITE. SHOWN By SOLID LINES.
2. FACILITIES FOR ALTERNATIVE PRODUCTION OF IMNAHA, UPPER GRANDE RONDE, AND CATHERINE CREEK CHS PRODUCTION ARE INDICATED BY DASHED LINES. INDICATES MAXIMUM SPACE NEEDED IF PRODUCTION REQUIREMENTS THROUGH FULL-TERM REARING ARE MET AT THIS SITE.
3. LAYOUT OF FACILITIES IS INTENDED TO SHOW GENERAL SPACE REQUIREMENTS AND DOES NOT REPRESENT FINAL RECOMMENDED CONFIGURATION.

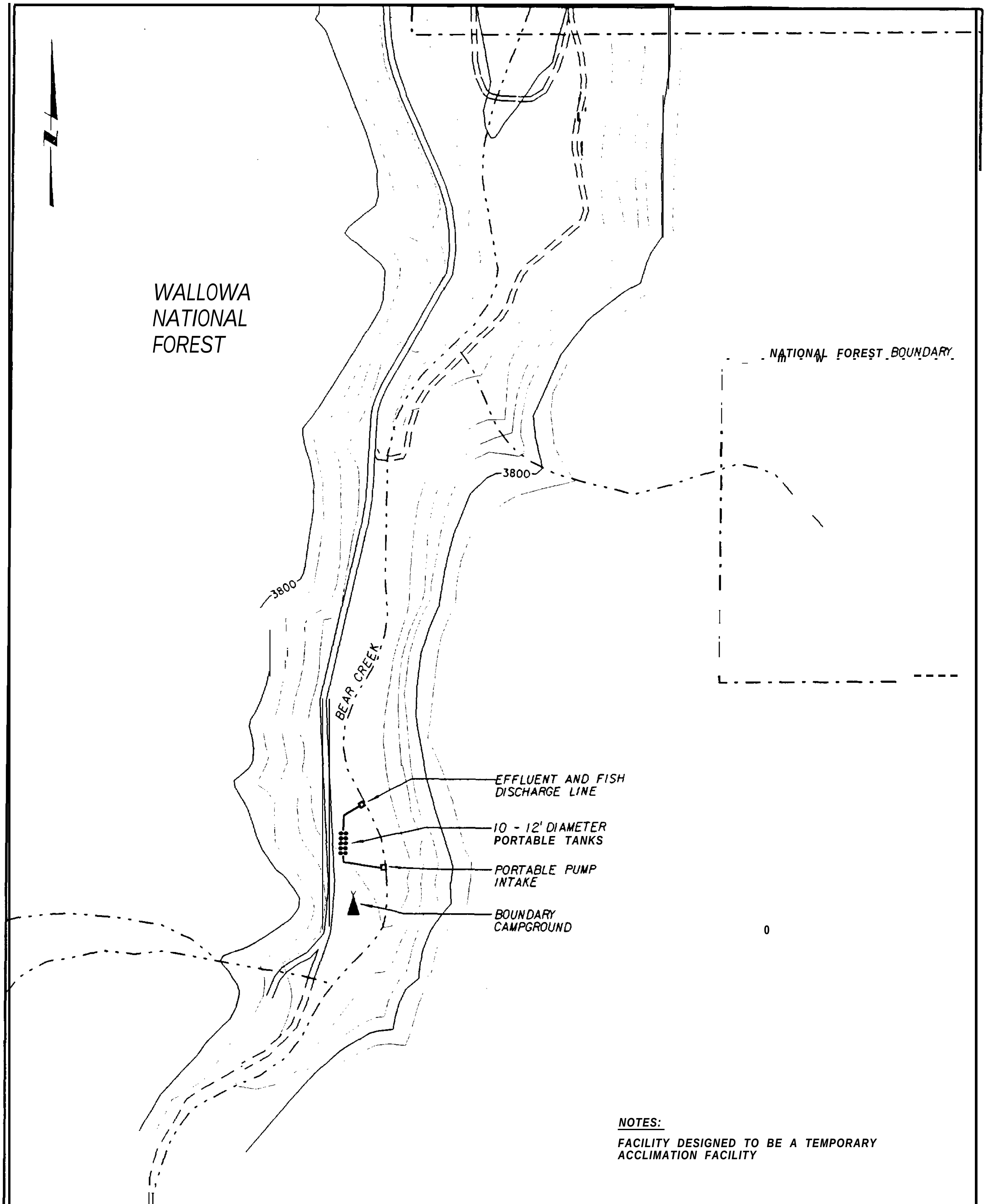
	LOSTINE CHS	IMNAHA, UPPER GRANDE RONDE, AND CATHERINE CREEK CHS
ADULT HOLDING (CF)	4,816	10,224
INCUBATION (8 STACK)	29	43
EARLY REARING (CF)	4,790	7,337
FULL TERM REARING (CF)	42,051	47,526

SCALE: 1"=200'

MONTGOMERY WATSON
Bellevue, Washington

BONNEVILLE POWER ADMINISTRATION
NORTHEAST OREGON HATCHERY PROJECT
STRATHEARN RANCH - LOSTINE RIVER
SPRING CHINOOK HATCHERY

FIGURE: 10



NOTES:

FACILITY DESIGNED TO BE A TEMPORARY ACCLIMATION FACILITY

NOVEMBER, 1994

SCALE:			FIGURE:
1"=500'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT BEAR CREEK SITE CHS ACCLIMATION FACILITY	11

TABLE 33

BONNEVILLE POWER ADMINISTRATION
ODFW BIGHORN SHEEP RANGE HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS	1	$60,000	$60,000	$60,000
SITEWORK:					
Clearing and Grubbing	AC	12.00	$1,500	$18,000	
Landscaping	LS	1	$15,000	$15,000	
Gravel surfacing (all driving surfaces)	CY	3,200	$15	$48,000	
Excavation - deposit on site	CY	8,000	$12	$96,000	
Engineered Fill	CY	800	$20	$16,000	
Fencing	LF	1,800	$18	$32,400	
Gates	EA	4	$600	$2,400	$227,800
ADULT HOLDING RACEWAYS					
Concrete	CY	125	$425	$53,125	
Slide Gates	EA	2	$10,000	$20,000	
Inlet Diffusers	SF	8	$75	$600	
Outlet Drain Plates	EA	2	$75	$150	
Outlet Pipe Winch & standpipe	EA	2	$800	$1,600	
Handrail	LF	200	$22	$4,400	
Piping and valves	LS	1	$20,000	$20,000	$99,875
EGG-TAKE STATION	SF	900	$120	$108,000	$108,000
HATCHERY BUILDING					
bldg is one floor incl. everything w/in walls except:	SF	6,200	$55	$341,000	
Incubators, 8 stack	EA	29	$950	$27,550	
Rearing troughs, 500 gal ea.	EA	77	$1,600	$123,200	$491,750
HEADTANK					
Cont. and misc. metals	CY	40	$475	$19,000	
piping. valves, weir, railing, and misc.	LS	1	$25,000	$25,000	$44,000
YARD PIPING					
Assume similar to **Merwin** Hatchery	LS	1	$400,000	$400,000	$400,000
OPERATIONS BUILDING building is one floor w/ feed room, garage, offices, lab. incl. everything w/in walls	SF	4,500	$68	$306,000	$306,000
RESIDENCES					
two 3 bdr houses, 1400 sf living area	SF	2,800	$62	$173,600	
two 400 sf garages	SF	800	$38	$30,400	$204,000

TABLE 33

BONNEVILLE POWER ADMINISTRATION
ODFW BIGHORN SHEEP RANGE HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

REARING PONDS (3)					
Earthwork	covered above under "sitework"				
subgrade	SY	3,250	$5	$16,250	
Asphaltic lining	SY	3,250	$10	$32,500	
Hydraulic structures	LS	3	$10,000	$30,000	$78,750
EFFLUENT PONDS (2)					
Earthwork	covered above under "sitework"				
subgrade	SY	3,100	$5	$15,500	
Asphaltic lining	SY	3,100	$10	$31,000	
Hydraulic structures	LS	2	$10,000	$20,000	$66,500
CARCASS DISPOSAL	LS	1	$30,000	$30,000	$30,000
RIVER INTAKE STRUCTURE					$160,000
RIVER EFFLUENT STRUCTURE					$25,000
POTABLE WELL WATER SYSTEM	LS	1	$10,000	$10,000	$10,000
UTILITY WATER PUMP STATION	LS	1	$12,000	$12,000	$12,000
INTAKE/EFFLUENT PIPING	LF	2100	$70	$70	$147,000
ELECTRICAL (7% of subtotal)	LS	1	$162,000	$162,000	$162,000
INSTRUMENTATION (0.5% of subtotal)	LS	1	$11,550	$11,550	$11,550
				SUBTOTAL	$2,312,295
				ESTIMATING CONTINGENCY (25%)	$578,074
				CONTRACTORS OH & PROFIT (20%)	$462,459
				TOTAL CONSTRUCTION COST (12/94)	$3,352,828

TABLE 3 4

BONNEVILLE POWER ADMINISTRATION
STRATHEARN RANCH HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS	1	$75,000	$75,000	$75,000
SITEWORK:					
Clearing and Grubbing	AC	7.00	$1,500	$10,500	
Landscaping	LS	1	$15,000	$15,000	
Gravel surfacing (all driving surfaces)	CY	2,100	$15	$31,500	
Excavation - deposit on site	CY	5,500	$12	$66,000	
Engineered Fill	CY	800	$20	$16,000	
Fencing	LF	1,800	$18	$32,400	
Gates	EA	4	$600	$2,400	$173,800
ADULT HOLDING RACEWAYS					
Concrete	CY	95	$425	$40,375	
Slide Gates	EA	2	$10,000	$20,000	
Inlet Diffusers	SF	8	$75	$600	
Outlet Dram Plates	EA	2	$75	$150	
Outlet Pipe Winch & standpipe	EA	2	$800	$1,600	
Handrail	LF	150	$22	$3,300	
Piping and valves	LS	1	$20,000	$20,000	$86,025
EGG-TAKE STATION	SF	900	$120	$108,000	$108,000
HATCHERY BUILDING					
bldg is one floor incl. everything w/in walls except:	SF	6,240	$55	$343,200	
Incubators, 8 stack	EA	29	$950	$27,550	
Rearing troughs, 500 gal ea.	EA	77	$1,600	$123,200	$493,950
HEADTANK					
Conc. and misc. metals	CY	50	$475	$23,750	
piping, valves, weir, railing. and misc.	LS	1	$25,000	$25,000	$48,750
YARD PIPING	LS	1	$400,000	$400,000	$400,000
OPERATIONS BUILDING	SF	4500	$68	$306,000	$306,000
building is one floor w/ feed room, garage, offices, lab. incl. everything w/in walls					
RESIDENCES					
two 3 bdr houses, 1400 sf living area	SF	2,800	$62	$173,600	
two 400 sf garages	SF	800	$38	$30,400	$204,000

TABLE 3 4

BONNEVILLE POWER ADMINISTRATION
STRATHEARN RANCH HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

REARING PONDS (3)					
Earthwork	covered above under "sitework"				
subgrade	**SY**	2,600	$5	$13,000	
Asphaltic lining	SY	2,600	$10	$26,000	
Hydraulic structures	LS	3	$10,000	$30,000	$69,000
EFFLUENT POND					
Earthwork	covered above under "sitework"				
subgrade	SY	1,400	$5	$7,000	
Asphaltic lining	SY	1,400	$10	$14,000	
Hydraulic structures	LS	2	$10,000	$20,000	$41,000
ACCLIMATION CHANNELS					
Gravel	CY	430	$18	$7,740	
Birdnetting (staked to ground)	SF	23,000	$1.75	$40,250	
Inlet structure	EA	2	$20,000	$40,000	
Outlet structure	EA	2	$15,000	$30,000	
Dewatering	EA	2	$20,000	$40,000	$157,990
CARCASS DISPOSAL	LS	1	$30,000	$30,000	$30,000
RIVER INTAKE STRUCTURE			$160,000	$160,000	$160,000
RIVER EFFLUENT STRUCTURE			$25,000	$25,000	$25,000
POTABLE WELL WATER SYSTEM	LS	1	$10,000	$10,000	$10,000
UTILITY WATER PUMP STATION	LS	1	$12,000	$12,000	$12,000
ELECTRICAL (7% of subtotal)	LS	1	$162,000	$181,600	$181,600
INSTRUMENTATION (0.5% of subtotal)	LS	1	$11,550	$13,000	$13,000
				SUBTOTAL	**$2,595,115**
				ESTIMATING CONTINGENCY (25%)	$648,779
				CONTRACTORS OH & PROFIT (20%)	$5 19,023
				TOTAL CONSTRUCTION COST (12/94)	**$3,762,917**

TABLE 3 5

BONNEVILLE POWER ADMINISTRATION
BEAR CREEK ACCLIMATION SITE
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATIO	LS			$2,000	$2,000
SITEWORK:					
Clearing and Grubbing	AC	1	$1,500	$1,500	
Cut	CY	100	$15	$1,500	
Fill	CY	100	$15	$1,500	
Erosion Control (rip-rap)	CY	15	$40	$600	$5.100
YARD PIPING	LS	1	$8,000	$8.000	$8,000
ACCLIMATION TANKAGE					
12' Dia FRP Tanks	EA	10	$2,100	$21,000	$21,000
PORTABLE PUMP SYSTEMS	EA	2	$4,000	$8,000	$8,000
RIVER STRUCTURES					
Intake structure	LS	1	$4,000	$4,000	
Outlet structure	LS	1	$1,000	$1,000	
Dew atering	LS	1	$2,000	$2,000	$7,000
ELECTRICAL/INSTRUMENTATIOI (trailer power)	LS	1	$10,000	$10,000	$10,000
				SUBTOTAL	$61,100
				ESTIMATING CONTINGENCY (25%)	$15,275
				CONTRACTORS OH & PROFIT (20%)	$12,220
				TOTAL CONSTRUCTION COST (12/94)	$88595

SITE LAYOUTS FOR IMNAHA

SPRING CHINOOK PROGRAM

INTRODUCTION

This section presents the site layouts of the facilities required for the Imnaha River Spring Chinook Program. These facilities and the preferred / alternative sites were listed in Table 16. Preferred sites for all production phases are located within the Imnaha subbasin (Figure 12). Alternative production sites are located out of basin, either at the Lostine River site or the Catherine Creek site.

The full-term rearing facility at the preferred hatchery site is shown as an engineered side-channel designed to maintain water flow during the winter with an ice cover on the surface. Winter water flow would be desired not only as intragravel flow, but also as an ice-free water column of varying depth. Very severe winters could potentially see ice thickness to the depth of the gravel. Design criteria for winter icing conditions beyond the assumptions made here would need to be defined prior to additional planning.

The final rearing / acclimation / direct release facilities on the Imnaha River follow a generic plan for a side-channel type of facility that could be developed at any of the three release sites under consideration.

The release sites within the area of the Big Sheep Creek / Lick Creek confluence are designed for the timed release fed fry program (early spring release of fry at 150/lb). Release site facilities consist of providing access to a number of potential sites adjacent to the creeks. Release would be into an improved or natural flowing pool type of environment. Minimal development or maintenance work is desired for these facilities.

MAXIMUM FACILITY REQUIREMENTS

Table 36 lists the maximum facility requirements for water supply (gpm) and volume (cf) required for the Imnaha program. The proposed layout to meet these requirements is also listed. The following drawings present a proposed site layout, emphasizing the ability of the preferred site to meet the space requirements. The final layout of the facilities at a site may differ from that shown in these drawings.

TABLE 36

MAXIMUM FACILITY REQUIREMENTS

IMNAHA SPRING CHINOOK

Facility	Site	Water Supply (gpm)	Volume (cuft)	Proposed Layout
Incubation		154	864,583 eggs	26 stacks of 8 trays/stack
Early Rearing		499	1,377	22 fry troughs each 2O'x2.5'x1.25' deep
Adult Holding/ Spawning		7.14	3,136	adult raceway
Timed Release Fed Fry		included below	included below	raceway
Full Term Rearing		4,305	24,693	12 raceways or pond
Final Rearing	Big Sheep-Lick Creek	653	4,935	natural or improved pool
	Mahogany Creek	1,642	13,048	side channel
	Stock Pond near Pallete Ranch	1,642	13,048	side channel
	College Creek	1,642	13.048	side channel

PRODUCTION TIMING AND TEMPERATURE CONSIDERATIONS

The temperature data for the Imnaha Spring Chinook program is based on the temperature from the USGS temperature station at the town of Imnaha. This temperature may be higher than for the Marks site, but temperature data for the Marks site is not available at this time. Temperature criteria consideration for the site based on the use of surface water for all phases is presented in the Table 37 for comparison of sites. During July, August and September, the surface water temperature is significantly higher than the temperature criteria for adult holding and rearing. It may be possible to develop 500-1000 gpm of groundwater at approximately 54 °F. Due to the relatively small amount of water used, temperature adjustment for incubation is generally not a significant problem.

Based on the production goals and growth rates presented in Table 5, four growth models were simulated:

TABLE 37

INFLUENCE OF WATER SOURCE ON GROWTH RATE

IMNAHA SPRING CHINOOK

Water Source	Actual Release Date @ 15/lb	Actual Release Date @ 20/lb	Desired Release Date	Comments
GW for Incubation and Early Rearing SW for Rearing	August 4	July 21	March - May 15	Need 1,000 to **3,000** gpm of GW to meet desired release dates
SW for Incubation, Early Rearing, and Rearing	August 11	July 2 1	March - May 15	Need 1,000 to **3,000** gpm of GW to meet desired release dates

GW = groundwater
SW = surface water or groundwater adjusted,to the local surface water temperature

The culture of spring chinook at this site will be difficult. There is little difference in timing between using groundwater or surface water for incubation and early rearing. To be able to meet the temperature criteria for rearing and timing, 1,000 to 3,000 gpm of groundwater is needed.

Relative heating and cooling requirements are shown on Table 38.

TABLE 38

COMPARISON OF ACTUAL TEMPERATURES, TEMPERATURE CRITERIA, AND DEGREE OF REQUIRED HEATING OR COOLING

Spring Chinook - Wayne Marks Ranch- Imnaha River

	Actual Temperature (°F)			Temperature Criteria (°F)				Required ΔT (°F)		
Month	10 % of Daily Minimum	Mean of Daily Average	75 % of Daily Maximum	Max Adult Holding	Min Incub	Max Incub	Max Rearing	Adult Holding	Incub	Rearing
Oct	41.5	48.7	53.7							
Nov	32.2	41.4	46.9							
Dec	32.0	35.1	39.0							
Jan	32.0	34.7	37.9							
Feb	32.1	37.5	42.1							
Mar	34.0	41.2	45.2							
Apr	39.2	46.2	51.3	63						
May	43.3	49.0	54.0	63						
Jun	47.0	54.7	60.1	63						
Jul	53.6	63.3	70.5	63				-7.5		
Aug	53.9	64.2	71.6	60	38	60		-11.6	-11.6	
Sep	48.1	56.8	64.1	60	38	60		-4.1	-4.1	
Oct	41.5	48.7	53.7		38	60				
Nov	32.2	41.4	46.9		38	60	63		+5.8	
Dec	32.0	35.1	39.0		38	60	63		+6	
Jan	32.0	34.7	37.9				63			
Feb	32.1	37.5	42.1				63			
Mar	34.0	41.2	45.2				63			
Apr	39.2	46.2	51.3				63			
May	43.3	49.0	54.0				63			
Jun	47.0	54.7	60.1				63			
Jul	53.6	63.3	70.5				63			-7.5
Aug	53.9	64.2	71.6				63			-8.6
Sep	48.1	56.8	64.1				63			-1.1
Oct	41.5	48.7	53.7				63			
Nov	32.2	41.4	46.9				63			
Dec	32.0	35.1	39.0				63			
Jan	32.0	34.7	37.9				63			
Feb	32.1	37.5	42.1				63			
Mar	34.0	41.2	45.2				63			
Apr	39.2	46.2	51.3				63			
May	43.3	49.0	54.0				63			
Jun	47.0	54.7	60.1							
Jul	53.6	63.3	70.5							
Aug	53.9	64.2	71.6							
Sep	48.1	56.8	64.1							

TABLE 39

REQUIRED FLOWS MARKS RANCH

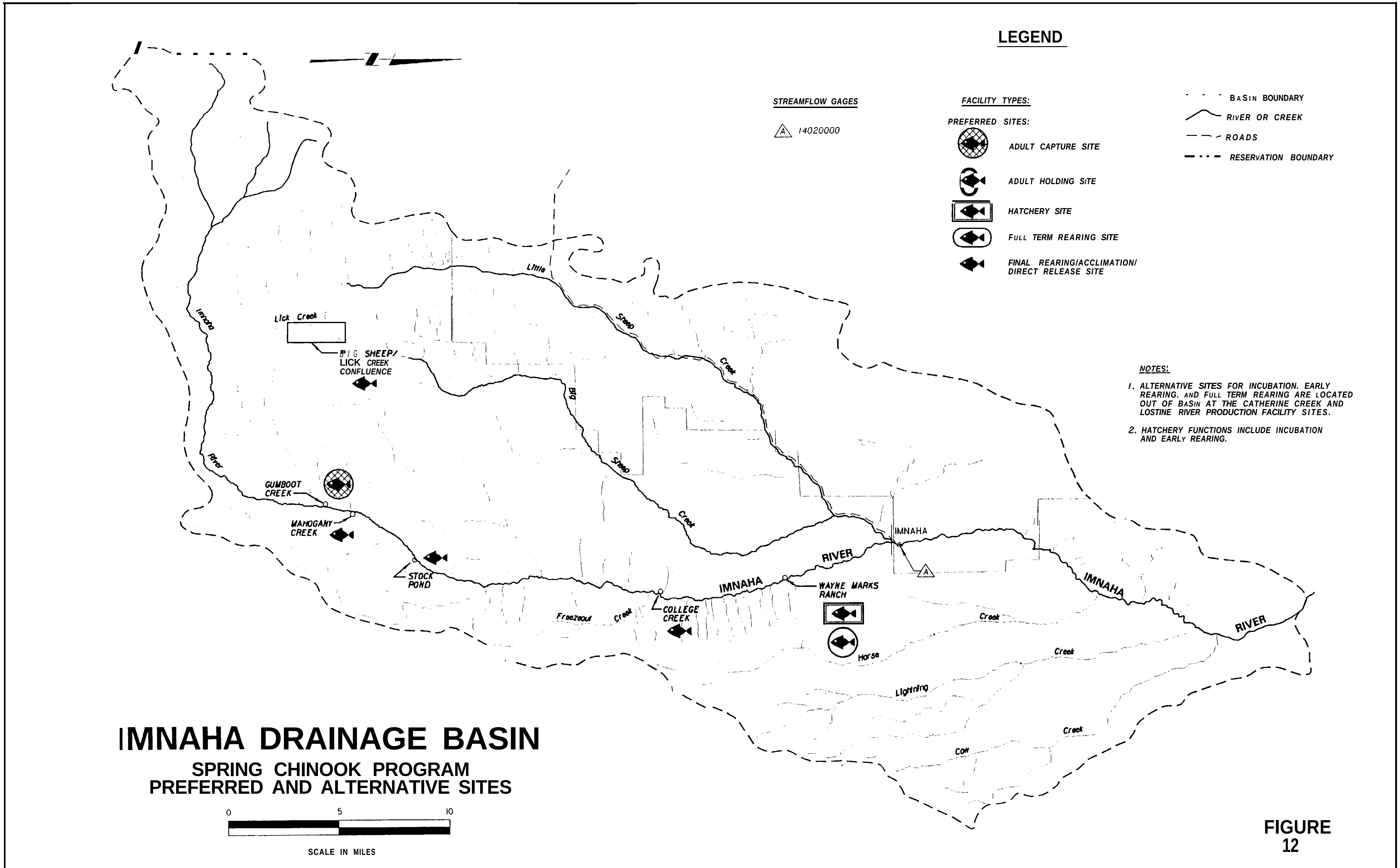
Week	Date	Adult Holding Surface Water Flow (gpm)	Incubation Groundwaler FIOW (gpm)	Early Rearing (Groundwater Flow (gpm)	Rearing Surface Water Flow (gpm)	Total Surface Flow (gpm)	Total GW FLOW (gpm)	Total Water Flow (gpm)
0	1-Jan	0		375		0	375	375
1	8-Jan	0		389		0	389	389
2	15-Jan	0		404		0	404	404
3	22-Jan	0		419		0	419	419
4	29-Jan	0			465	465	0	465
5	5-Feb	0			486	486	0	486
6	12-Feb	0			503	503	0	503
7	19-Feb	0			511	511	0	511
8	26-Feb	0			579	579	0	579
9	5-Mar	0			588	588	0	588
10	12-Mar	0			622	622	0	622
111	19-Mar	0			653	653	0	653
12	26-Mar	0			737	737	0	737
13	2-Apr	0			792	792	0	792
14	9-Apr	0			911	911	0	911
15	16-Apr	48			949	997	0	997
16	23-Apr	118			969	1087	0	1087
17	30-Apr	182			1179	1361	0	1361
18	7-May	245			1284	1530	0	1530
19	14-May	307			1389	1696	0	1696
20	21-May	384			1487	1871	0	1871
21	28-May	397			1638	2035	0	2035
22	4-Jun	453			1782	2235	0	2235
23	11-Jun	467			2153	2620	0	2620
24	18-Jun	509			2367	2877	0	2877
25	25-Jun	540			2750	3290	0	3290
26	2-Jul	578			3064	3642	0	3642
27	9-Jul	634			3447	4081	0	4081
28	16-Jul	666			4004	4670	0	4670
29	[illegible]-Jul	714			4536	5249	0	5249
30						5890	0	5890
31	30-.6-Aug	626	130		5601	6228	130	6358
32	13-Aug	570	130		5824	6394	130	6523
33	20-Aug	520	130			520	130	650
34	27-Aug	433	130			433	130	563
35	3-Sep	355	130			355	130	484
36	10-Sep	268	130			268	130	397
37	17-Sep	186	130			186	130	316
38	24-Sep	91	130			91	130	221
39	1-Oct	0	130			0	130	130
40	8-Oct	0	130			0	130	130
41	15-Oct	0	130			0	130	130
42	22-Oct	0		246		0	246	246
43	29-Oct	0		284		0	284	284
44	5-Nov	0		317		0	317	317
45	12-Nov	0		325		0	325	325
46	19-Nov	0		339		0	339	339
47	26-Nov	0		304		0	304	304
48	3-Dec	0		306		0	306	306
49	10-Dec	0		319		0	319	319
50	17-Dec	0		333		0	333	333
51	24-Dec	0		347		0	347	347
52	31-Dec	0		361		0	361	361
	Maximum	714	130		5824	6394	419	6523

SITE LAYOUTS

Imnaha spring chinook site layouts are depicted on the following figures.

PRELIMINARY COST ESTIMATES

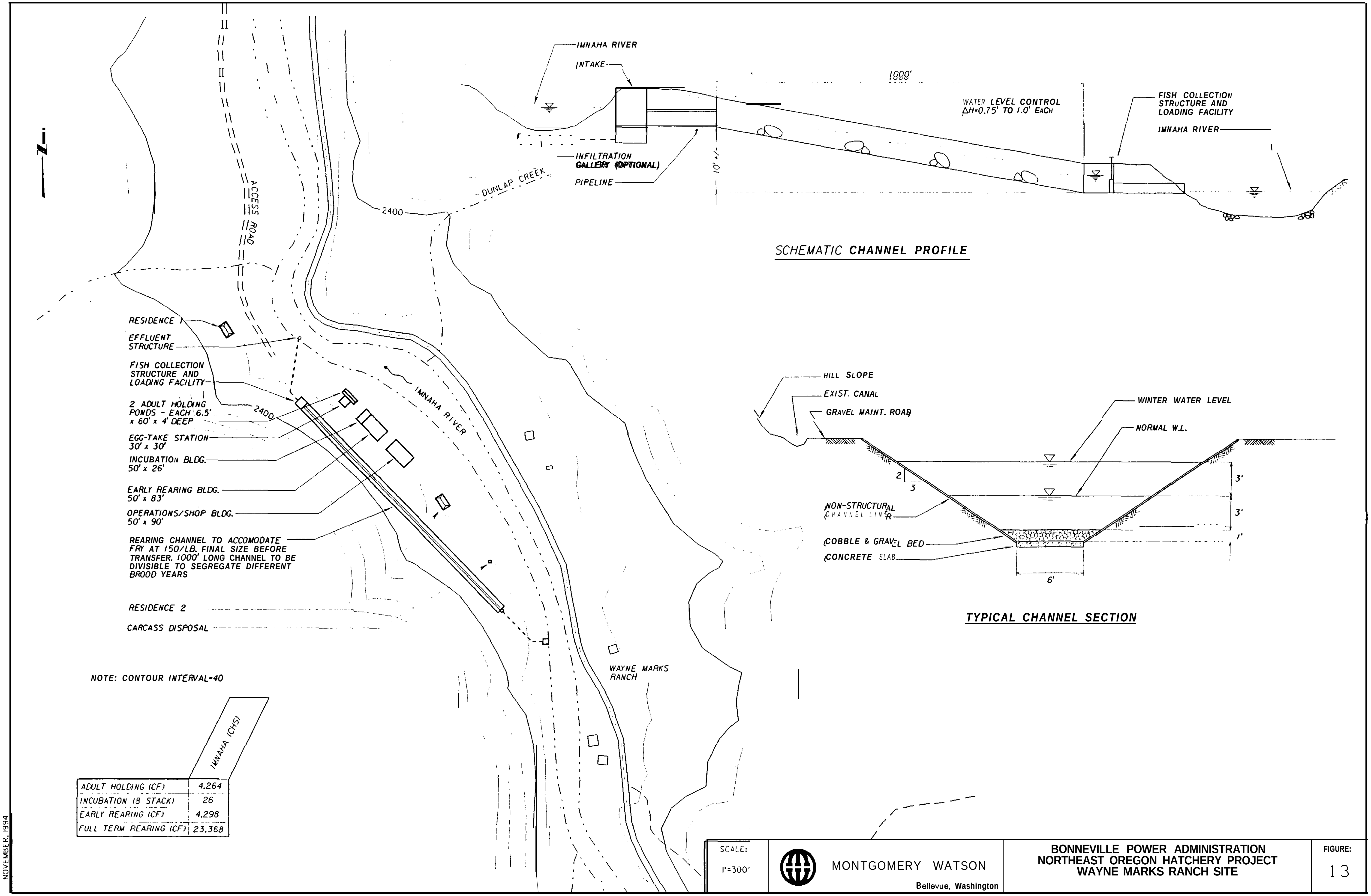
Preliminary cost estimates (+50%, - 30%) for the Imnaha spring chinook program are shown on Tables 40 through 44.

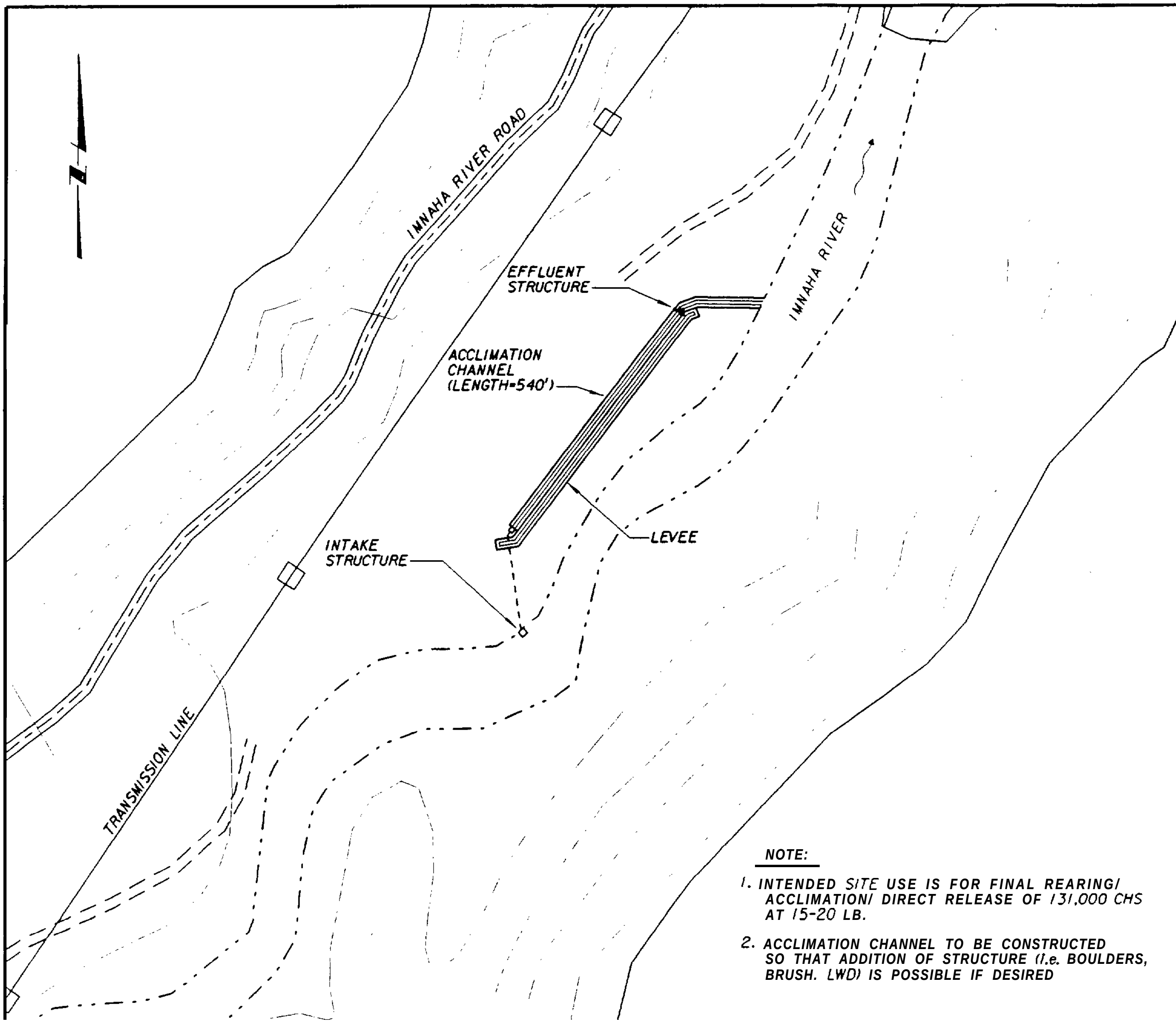


IMNAHA DRAINAGE BASIN

SPRING CHINOOK PROGRAM
PREFERRED AND ALTERNATIVE SITES

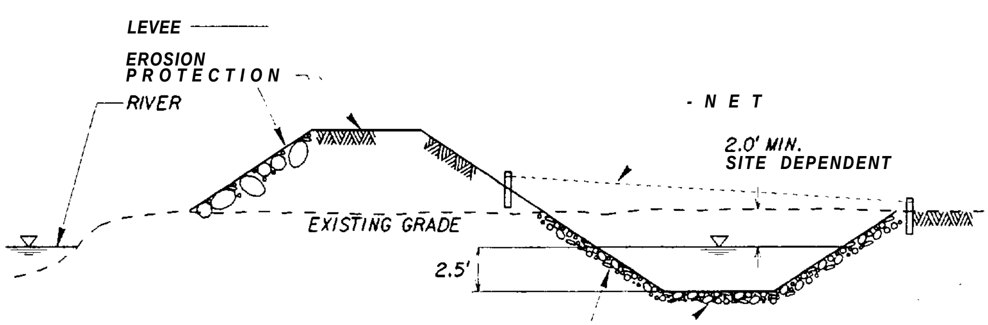
FIGURE 12


IMNAHA RIVER
INTAKE
1000'
WATER LEVEL CONTROL
ΔH=0.75' TO 1.0' EACH
FISH COLLECTION STRUCTURE AND LOADING FACILITY
IMNAHA RIVER
INFILTRATION GALLERY (OPTIONAL)
PIPELINE
10' +/-
SCHEMATIC CHANNEL PROFILE
DUNLAP CREEK
2400
ACCESS ROAD
RESIDENCE 1
EFFLUENT STRUCTURE
FISH COLLECTION STRUCTURE AND LOADING FACILITY
2 ADULT HOLDING PONDS - EACH 6.5' x 60' x 4' DEEP
EGG-TAKE STATION 30' x 30'
INCUBATION BLDG. 50' x 26'
EARLY REARING BLDG. 50' x 83'
OPERATIONS/SHOP BLDG. 50' x 90'
REARING CHANNEL TO ACCOMODATE FRY AT 150/LB. FINAL SIZE BEFORE TRANSFER. 1000' LONG CHANNEL TO BE DIVISIBLE TO SEGREGATE DIFFERENT BROOD YEARS
RESIDENCE 2
CARCASS DISPOSAL
IMNAHA RIVER
WAYNE MARKS RANCH
NOTE: CONTOUR INTERVAL=40
HILL SLOPE
EXIST. CANAL
GRAVEL MAINT. ROAD
WINTER WATER LEVEL
NORMAL W.L.
NON-STRUCTURAL CHANNEL LINER
COBBLE & GRAVEL BED
CONCRETE SLAB
2
3
3'
3'
1'
6'
TYPICAL CHANNEL SECTION
IMNAHA (CHS)
ADULT HOLDING (CF) 4,264
INCUBATION (8 STACK) 26
EARLY REARING (CF) 4,298
FULL TERM REARING (CF) 23,368
SCALE: 1"=300'
MONTGOMERY WATSON
Bellevue, Washington
BONNEVILLE POWER ADMINISTRATION
NORTHEAST OREGON HATCHERY PROJECT
WAYNE MARKS RANCH SITE
FIGURE: 13
NOVEMBER, 1994



NOTE:

1. INTENDED SITE USE IS FOR FINAL REARING/ ACCLIMATION/ DIRECT RELEASE OF 131,000 CHS AT 15-20 LB.
2. ACCLIMATION CHANNEL TO BE CONSTRUCTED SO THAT ADDITION OF STRUCTURE (i.e. BOULDERS, BRUSH, LWD) IS POSSIBLE IF DESIRED

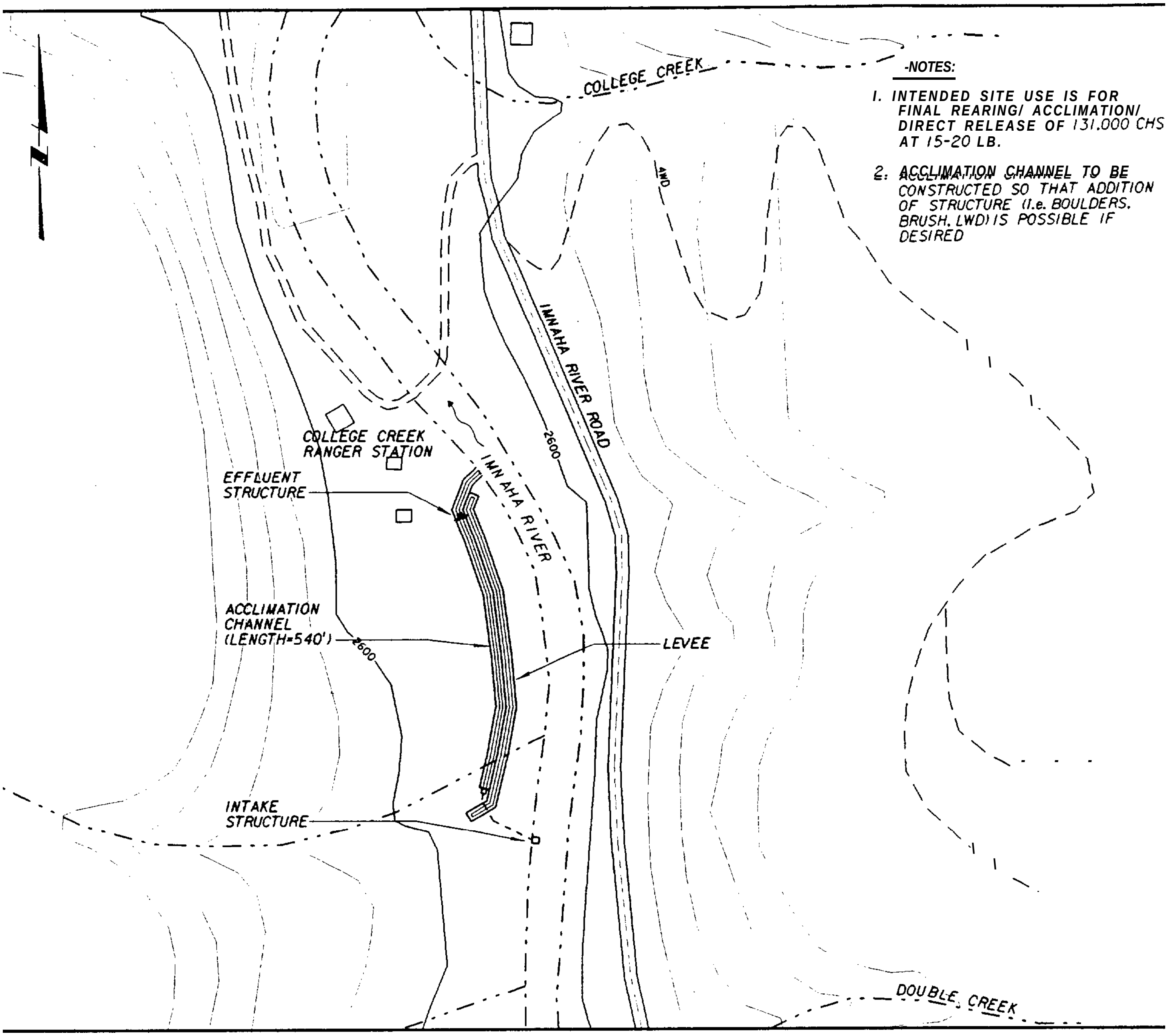


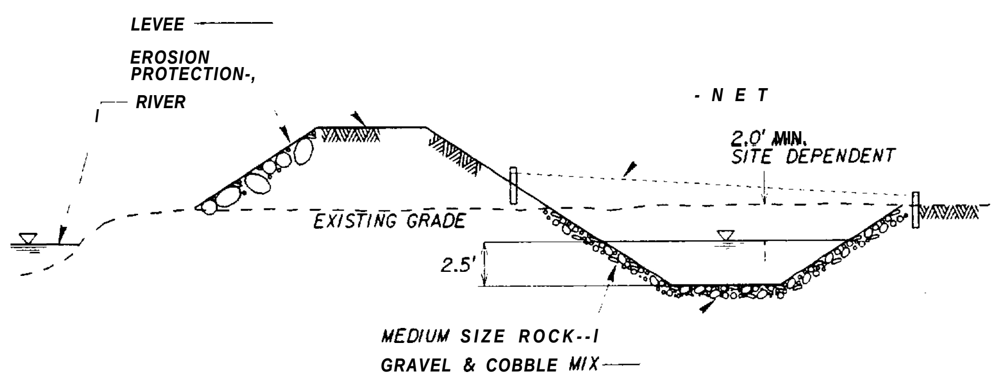
TYPICAL CHANNEL SECTION

NO SCALE

NOVEMBER, 1994

SCALE: 1"=300'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT MAHOGANY CREEK – IMNAHA RIVER CHS ACCLIMATION CHANNEL	FIGURE: 14

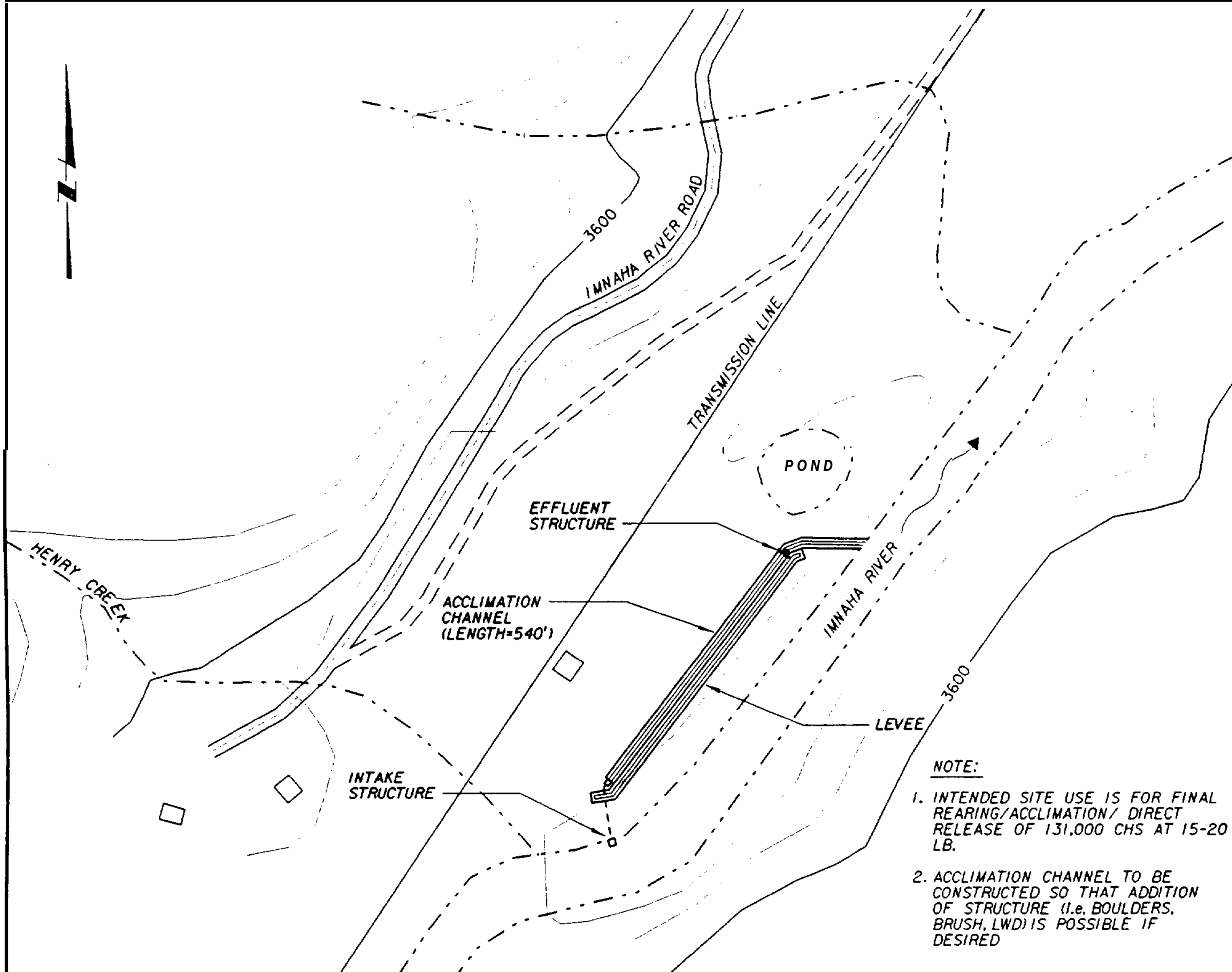




TYPICAL CHANNEL SECTION

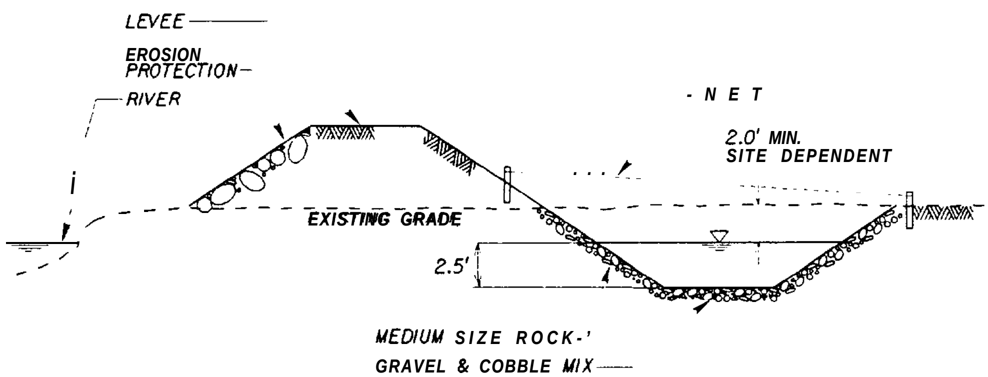
NO SCALE

SCALE: 1"=300'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT COLLEGE CREEK – IMNAHA RIVER CHS ACCLIMATION CHANNEL	FIGURE: 15



NOTE:

1. INTENDED SITE USE IS FOR FINAL REARING/ACCLIMATION/ DIRECT RELEASE OF 131,000 CHS AT 15-20 LB.
2. ACCLIMATION CHANNEL TO BE CONSTRUCTED SO THAT ADDITION OF STRUCTURE (I.e. BOULDERS, BRUSH, LWD) IS POSSIBLE IF DESIRED

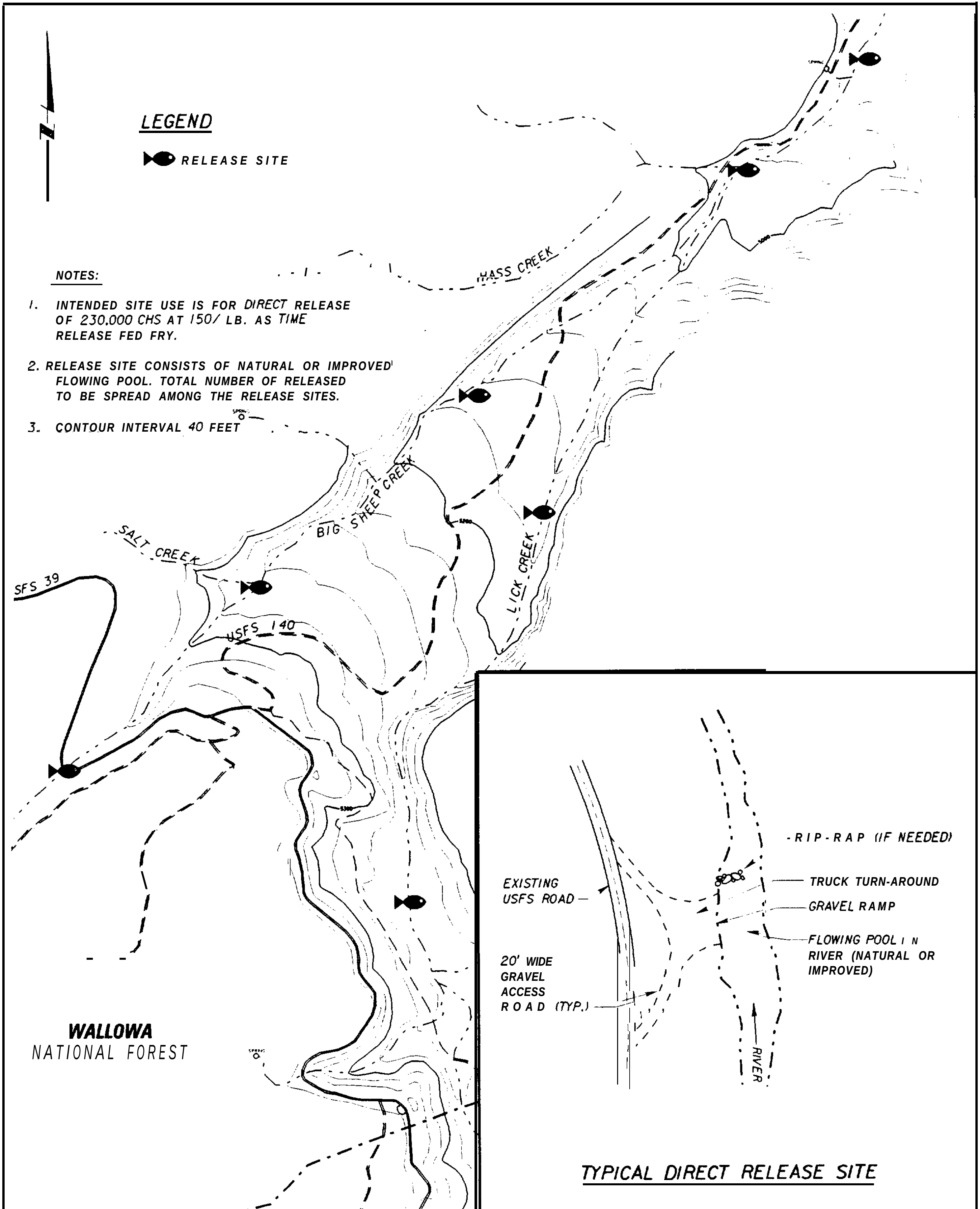


TYPICAL CHANNEL SECTION

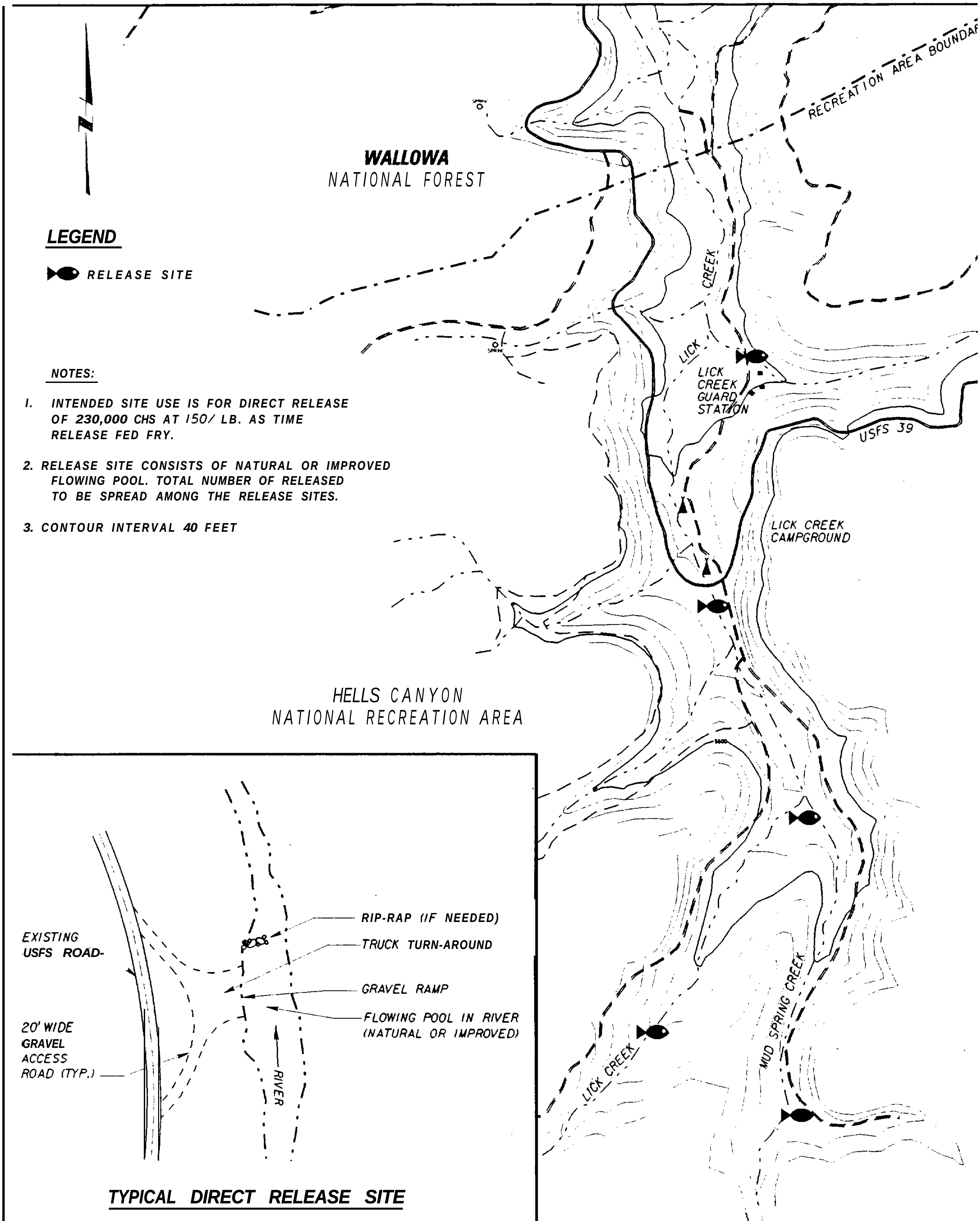
NO SCALE

NOVEMBER 1994

SCALE: 1"=300'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT **STOCK POND – IMNAHA RIVER**	FIGURE: 16



SCALE: 1"=1500'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT BIG SHEEP-LICK CREEK SITE - SHEET 1 OF 2 CHS DIRECT RELEASE SITES	FIGURE: 17A



LEGEND

RELEASE SITE

NOTES:

1. INTENDED SITE USE IS FOR DIRECT RELEASE OF 230,000 CHS AT 150/ LB. AS TIME RELEASE FED FRY.

2. RELEASE SITE CONSISTS OF NATURAL OR IMPROVED FLOWING POOL. TOTAL NUMBER OF RELEASED TO BE SPREAD AMONG THE RELEASE SITES.

3. CONTOUR INTERVAL 40 FEET

TYPICAL DIRECT RELEASE SITE

SCALE: 1'=1500'	MONTGOMERY WATSON Bellevue. Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT BIG SHEEP-LICK CREEK SITE - SHEET 2 OF 2 CHS DIRECT RELEASE SITES	FIGURE: 17B

TABLE 40

BONNEVILLE POWER ADMINISTRATION
WAYNE MARKS RANCH SITE HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS	1	$60,000	$60,000	$60,000
SITEWORK:					
Clearing and Grubbing	AC	4.50	$1,500	$6,750	
Landscaping	LS	1	$5,000	$5,000	
Gravel surfacing (all driving surfaces)	CY	1,200	$15	$18,000	
Excavation -deposit on site	CY	6,800	$12	$81,600	
Engineered Fill	CY	400	$20	$8,000	
Erosion Control (rip-rap)	CY	200	$60	$12,000	
Fencing	LF	200	$18	$3,600	
Gates	EA	2	$600	$1,200	$136,150
ADULT HOLDING RACEWAYS					
Concrete	CY	90	$450	$40,500	
Slide Gates	EA	2	$10,000	$20,000	
Inlet Diffusers	SF	8	$75	$600	
Outlet Drain Plates	EA	2	$75	$150	
Outlet Pipe Winch & standpipe	EA	2	$800	$1,600	
Handrail	LF	180	$22	$3,960	
Piping and valves	LS	1	$15,000	$15,000	$81,810
EGG-TAKE STATION	SF	900	$120	$108,000	$108,000
HATCHERY BUILDING					
bldg is one floor incl. everything w/in walls except:	SF	4,700	$55	$258,500	
Incubators, 8 stack	EA	26	$950	$24,700	
Rearing troughs, 500 gal ea	EA	69	$1,600	$110,400	$393,600
HEADTANK					
Conc. and misc. metals	CY	30	$475	$14,250	
piping, valves, weir, railing, and misc.	LS	1	$20,000	$20,000	$34,250
YARD PIPING					
Assume similar to Merwin Hatchery	LS	1	$400,000	$400,000	$400,000
OPERATIONS BUILDING building is one floor w/ feed room, garage, offices. lab. incl. everything w/in walls	SF	4.500	$68	$306,000	$306,000
RESIDENCES					
two 3 bdr houses, 1400 sf living area	SF	2,800	$62	$173,600	
two 400 sf garages	SF	800	$38	$30,400	$204,000
REARING CHANNEL					
Earthwork	covered above under "sitework"				
Non-structural liner	SF	48,000	$2.25	$108,000	
Concrete	CY	115	$350	$40,250	
Gravel	CY	250	$18	$4,500	
Hydraulic structures	EA	2	$15,000	$30,000	$182,750
CARCASS DISPOSAL	LS	1	$30,000	$30,000	$30,000

TABLE 40

BONNEVILLE POWER ADMINISTRATION
WAYNE MARKS RANCH SITE HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

RIVER INTAKE STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	50	$475	$23,750	
Misc. metals	LS	1	$4,500	$4,500	
Wedgewire screen	SF	350	$90	$31,500	
Sluice gale	EA	1	$3,000	$3,000	
Automatic screen cleaner	EA	1	$70,000	$70,000	
Baffles	LS	1	$5,000	$5,000	
stoplogs	LS	1	$9,000	$9,000	
Pipe specials	LS	1	$3,000	$3,000	
Dewatering	LS	1	$12,000	$12,000	$161,750
RIVER EFFLUENT STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	40	$475	$19,000	
Misc. metals	LS	1	$2,000	$2,000	
Dewatering	LS	1	$5,000	$5,000	$26,000
POTABLE WELL WATER SYSTEM	LS	1	$10,000	$10,000	$10,000
UTILITY WATER PUMP STATION	LS	1	$12,000	$12,000	$12,000
RIVER INTAKE PUMP STATION	(for hatchery bldg. only).				
Pump station slab & encase	CY	20	$250	$5,000	
Pumps	EA	3	$10,000	$30,000	
Flow meter w/ vault	EA	1	$3,000	$3,000	
Valves	LS	1	$8,000	$8,000	
Piping	EA	1	$10,000	$10,000	
Protective Coatings	EA	1	$1,000	$1,000	
Pump Panel	EA	1	$15,000	$15,000	
Controls (basic)	EA	1	$3,500	$3,500	$75,500
ELECTRICAL (7% of subtotal)	LS	I	$168,000	$168,000	$168,000
INSTRUMENTATION (0.5% of subtotal)	LS	1	$12,000	$12,000	$12,000
				SUBTOTAL	$2,401,810
				ESTIMATING CONTINGENCY (25%)	$600,453
				CONTRACTORS OH & PROFIT (20%)	$480,362
				TOTAL CONSTRUCTION COST (12/94)	$3,482,625

TABLE 41

BONNEVILLE POWER ADMINISTRATION
MAHOGANY CREEK ACCLIMATION CHANNEL
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS			$7500	$75OO
SITEWORK:					
Clearing and Grubbing	AC	2.50	$1,500	$3,750	
Cut - deposit as berm	CY	1,300	$15	$19,500	
Rock excavation (assumed)	CY	30	$70	$2,100	
Erosion Control (rip-rap)	CY	100	$50	$5,000	
gravel access road	CY	200	$15	$3,000	
Gravel channel lining	CY	250	$16	$4,000	$37,350
IN-CHANNEL HYDRAULIC STRUCTURES	LS	1	$8,000	$8,000	$8,000
RIVER INTAKE STRUCTURE	LS	1	$15,000	$15,000	
Dewatering	LS	1	$5,000	$5,000	$20,000
RIVER OUTLET STRUCTURE	LS	1	$10,000	$l0,000	
Dewatering	LS	1	$2,500	$2,500	$12,500
INFLUENT PIPING	LF	150	$55	$8,250	$8,250
BIRDNETTING (staked to ground)	SF	12,500	$1.50	$18,750	$18,750
				SUBTOTAL	$112,350
				ESTIMATING CONTINGENCY (25%)	$28,088
				CONTRACTORS OH & PROFIT (20%)	$22,470
				TOTAL CONSTRUCTION COST (12/94)	$162,908

TABLE 42

BONNEVILLE POWER ADMINISTRATION
COLLEGE CREEK ACCLIMATION CHANNEL
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS			$7,500	$7,500
SITEWORK:					
Clearing and Grubbing	AC	2.50	$1,500	$3,750	
Cut - deposit as berm	CY	1,300	$15	$19,500	
Rock excavation (assumed)	CY	30	**$70**	$2,100	
Erosion Control (rip-rap)	CY	100	$50	$5,000	
gravel access road	CY	200	$15	$3,000	
Gravel channel lining	CY	250	$16	$4,000	$37,350
IN-CHANNEL HYDRAULIC STRUCTURES	LS	1	$8,000	$8,000	$8,000
RIVER INTAKE STRUCTURE	LS	1	$15,000	$15,000	
Dewatering	LS	1	$5,000	$5,000	$20,000
RIVER OUTLET STRUCTURE	LS	1	$10,000	$10,000	
Dew atering	LS	1	$2,500	$2,500	$12,500
INFLUENT PIPING	LF	150	$55	$8,250	$8,250
BIRDNETTING (staked to ground)	SF	12,500	$1.50	$18,750	$18,750
				SUBTOTAL	$112,350
				ESTIMATING CONTINGENCY (25%)	$28,088
				CONTRACTORS OH & PROFIT (20%)	**$22,470**
				TOTAL CONSTRUCTION COST (12/94)	**$162,908**

TABLE 43

BONNEVILLE POWER ADMINISTRATION
STOCK POND ACCLIMATION CHANNEL
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS			$7,500	$7,500
SITEWORK:					
Clearing and Grubbing	AC	2.50	$1,500	$3,750	
Cut - deposit as berm	CY	1,300	$15	$19,500	
Rock excavation (assumed)	CY	30	$70	$2,100	
Erosion Control (rip-rap)	CY	100	$50	$5,000	
gravel access road	CY	200	$15	$3,000	
Gravel channel lining	CY	250	$16	$4,000	$37,350
IN-CHANNEL HYDRAULIC STRUCTURES	LS	1	$8,000	$8,000	$8,000
RIVER INTAKE STRUCTURE	LS	1	$15,000	$15,000	
Dew atering	LS	1	$5,000	$5,000	$20,000
RIVER OUTLET STRUCTURE	LS	1	$10,000	$10,000	
Dewatering	LS	1	$2,500	$2,500	$12,500
INFLUENT PIPING	LF	150	$55	$8,250	$8,250
BIRDNETTING (staked to ground)	SF	12,500	$1.50	$18,750	$18,750
				SUBTOTAL	$112,350
				ESTIMATING CONTINGENCY (25%)	$28,088
				CONTRACTORS OH & PROFIT (20%)	$22,470
				TOTAL CONSTRUCTION COST (12/94)	$162,908

TABLE 44

BONNEVILLE POWER ADMINISTRATION
BIG SHEEP - LICK CREEK DIRECT RELEASE SITES
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATIO	LS			$2,000	$2,000
SITEWORK:					
(assume no fencing)					
Clearing and Grubbing	AC	1	$1,500	$1,500	
Cut (assumed)	CY	50	$15	$750	
Fill (assumed)	CY	50	$15	$750	
Erosion Control (rip-rap)	CY	20	$40	$800	
Gravel road	CY	75	$15	$1,125	$4,925
				SUBTOTAL	$6,925
				ESTIMATING CONTINGENCY (25%)	$1,731
				CONTRACTORS OH & PROFIT (20%)	$1,385
				TOTAL CONSTRUCTION COST PER SITE (12/94)	$10,041
				INITIAL PROGRAM (3 sites)	$30,124
				SECOND PHASE (9 sites)	$90,371
				TOTAL PROGRAM CONSTRUCTION COST (12 sites)	$120,495

SITE LAYOUTS FOR WALLA WALLA - TOUCHET

SPRING CHINOOK PROGRAM

INTRODUCTION

This section presents the site layouts of the facilities required for the Walla Walla - Touchet Spring Chinook Program. These facilities and the preferred / alternative sites were listed in Table 17. Preferred sites for all production phases are located within the Walla Walla subbasin (Figure 18). Alternative production sites are also located within the Walla Walla basin.

MAXIMUM FACILITY REQUIREMENTS

Table 45 lists the maximum facility requirements for water supply (gpm) and volume (cf) required for the Walla Walla - Touchet program. The proposed layout to meet these requirements is also listed. The following drawings present a proposed site layout, emphasizing the ability of the preferred site to meet the space requirements. The final layout of the facilities at a site may differ from that shown in these drawings.

TABLE 45

MAXIMUM FACILITY REQUIREMENTS

WALLA WALLA - TOUCHET SPRING CHINOOK

Facility	**Site**	Water Supply **(gpm)**	Volume **(cuft)**	**Proposed Layout**
Incubation	Russell Walker Ranch	157	880,425 eggs	26 stacks of 8 travs/stack
Early Rearing	Russell Walker Ranch	993	1,377	22 fry troughs each 2O'x2.5'x1.25' deep
Adult Holding/ Spawning	Russell Walker Ranch	839	4,472	Adult Raceways
Full Term Rearing	Russell Walker Ranch	10,012	62,212	25 raceways each lO'xlOO'x2.5' deep
Final Rearing	Russell Walker Pond @ FS Bndy Wolf to S. Fork	7,702 1,979 1,979	65,257 16,314 16,314	ponds/side channel existing pond pond/side channel

PRODUCTION TIMING AND TEMPERATURE CONSIDERATIONS

The temperature data for the Walla Walla and Touchet Rivers Spring Chinook program is based on the temperature from the Russell Walker site. Temperature criteria consideration for the site based on the use of surface water for all phases is presented in the Table 46 for comparison of sites. This is an excellent site for the culture of all phases from adult holding to final rearing. Little or no temperature adjustment will be required to meet the temperature criteria as long as surface water temperatures are matched during production phases.

Based on the production goals and growth rates presented in Table 5, two growth models were simulated:

TABLE 46

INFLUENCE OF WATER SOURCE ON GROWTH RATE

WALLA WALLA - TOUCHET SPRING CHINOOK

Water Source	Actual Release Date @ 10b	Desired Release Date	Comments
GW for Incubation and Early Rearing SW for Rearing	October 27	March - May 15	Need to simulate SW temperature profile
SW for Incubation, Early Rearing, and Rearing	March 30	March -May 15	Meets desired release date

GW = groundwater
SW = surface water or groundwater adjusted to the local surface water temperature

The use of groundwater for incubation and early rearing results in too rapid growth of spring chinook. Disinfected surface water or groundwater adjusted to the local surface water results is much better timing. Groundwater can be used to cool the rearing water during the summer to help adjust production timing.

Relative heating and cooling requirements are shown on Table 47.

TABLE 47

COMPARISON OF ACTUAL TEMPERATURES, TEMPERATURE CRITERIA, AND DEGREE OF REQUIRED HEATING OR COOLING

Spring Chinook - Russell Walker Ranch - S. Fork Walla Walla River

	Actual Temperature (F)			Temperature Criteria (F)				Required AT (F)		
Month	10 % of Daily Min.	50% of Daily Average	75 % of Daily Max.	Max Adult Holding	Min Incub	Max Incub	Max Rearing	Adult Holding	Incub	Rearing
Oct	42.1	44.6	46.0							
Nov	37.9	40.7	42.1							
Dec	37.0	39.5	41							
Jan	36.0	38.5	39.9							
Feb	37.0	39.6	41							
Mar	37.9	40.3	43.0							
Apr	39.0	42.1	44.5	63						
May	41	44.8	48.9	63						
Jun	46.0	51.8	57.9	63						
Jul	48.0	54.3	61.0	63						
Aug	46.9	52.5	59	60	38	60				
Sep	45.0	48.8	52.0	60	38	60				
Oct	42.1	44.6	46.0		38	60				
Nov	37.9	40.7	42.1		38	60	63		+0.1	
Dec	37.0	39.5	41		38	60	63		+1.0	
Jan	36.0	38.5	39.9				63			
Feb	37.0	39.6	41				63			
Mar	37.9	40.3	43.0				63			
Apr	39.0	42.1	44.5				63			
May	41	44.8	48.9				63			
Jun	46.0	51.8	57.9				63			
Jul	48.0	54.3	61.0				63			
Aug	46.9	52.5	59				63			
Sep	45.0	48.8	52.0				63			
Oct	42.1	44.6	46.0				63			
Nov	37.9	40.7	42.1				63			
Dec	37.0	39.5	41				63			
Jan	36.0	38.5	39.9				63			
Feb	37.0	39.6	41				63			
Mar	37.9	40.3	43.0				63			
Apr	39.0	42.1	44.5				63			
May	41	44.8	48.9				63			
Jun	46.0	51.8	57.9							
Jul	48.0	54.3	61.0							
Aug	46.9	52.5	59							
Sep	45.0	48.8	52.0							

TABLE 48

REQUIRED FLOWS
RUSSEL WALKER SITE

	Adult Holding Surface Water Flow (gpm)	Incubation Groundwater Flow (gpm)	Early Rearing Groundwater Flow (gpm)	Rearing Surface Water Flow (gpm)	Reservoir Surface Flow (gpm)	Total Surface Flow (gpm)	Total Surface Flow (cfs)	Total GW Flow (gpm)	Total Water Flow (gpm)
Date									
1-Jan									
8-Jan	0	283	0	5392	0	5392	12	283	5675
15-Jan	0	283	0	5759	0	5759	13	283	6042
22-Jan	0	283	0	5655	0	5655	13	283	5938
29-Jan	0	283	0	5778	0	5778	13	283	6061
5-Feb	0	283	0	6362	0	6362	14	283	6645
12-Feb	0	283	0	6554	0	6554	15	283	6837
19-Feb	0	283	0	6414	0	6414	14	283	6697
26-Feb	0	0	367	6410	0	6410	14	367	6777
5-Mar	0	0	365	5884	0	5884	13	365	6250
12-Mar	0	0	419	6674	0	6674	15	419	7093
19-Mar	0	0	475	7053	0	7053	16	475	7527
26-Mar	0	0	531	7409	0	7409	17	531	7939
2-Apr	0	0	540	7136	0	7136	16	540	7677
9-Apr	303	0	612	7635	0	7938	18	612	8550
16-Apr	553	0	640	7757	0	8310	19	640	8950
23-Apr	855	0	685	7873	0	8727	19	685	9412
30-Apr	1413	0	809	8568	0	9980	22	809	10789
7-May	1641	0	844	8624	0	10265	23	844	11109
14-May	2236	0	966	9217	0	11452	26	966	12418
21-May	2372	0	1065	9493	0	11865	26	1065	12930
28-May	2367	0	1174	0	0	2367	5	1174	3541
4-Jun	2958	0	0	1697	0	4654	10	0	4654
11-Jun	3196	0	0	1944	0	5140	11	0	5140
18-Jun	3440	0	0	2284	0	5724	13	0	5724
25-Jun	3818	0	0	2562	0	6380	14	0	6380
2-Jul	3776	0	0	2750	0	6526	15	0	6526
9-Jul	3803	0	0	3008	0	6811	15	0	6811
16-Jul	4212	0	0	3368	0	7581	17	0	7581
23-Jul	4257	0	0	3710	0	7967	18	0	7967
30-Jul	4060	0	0	3877	0	7937	18	0	7937
6-Aug	3512	0	0	4103	0	7615	17	0	7615
13-Aug	3361	0	0	4374	0	7736	17	0	7736
20-Aug	2942	0	0	4617	0	7559	17	0	7559
27-Aug	2319	0	0	4846	0	7166	16	0	7166
3-Sep	2047	283	0	5035	0	7083	16	283	7366
10-Sep	1695	283	0	5068	0	6763	15	283	7046
17-Sep	1642	283	0	5391	0	7032	16	283	7315
24-Sep	1462	283	0	5215	0	6677	15	283	6960
1-Oct	928	283	0	5599	0	6527	15	283	6810
8-Oct	823	283	0	5403	0	6226	14	283	6509
15-Oct	744	283	0	5372	0	6116	14	283	6399
22-Oct	748	283	0	5545	0	6293	14	283	6576
29-Oct	771	283	0	5931	0	6702	15	283	6985
5-Nov	669	283	0	5573	0	6243	14	283	6526
12-Nov	577	283	0	5330	0	5907	13	283	6190
19-Nov	393	283	0	5044	0	5437	12	283	5720
26-Nov	392	283	0	5522	0	5914	13	283	6197
3-Dec	306	283	0	5402	0	5708	13	283	5991
10-Dec	231	283	0	5311	0	5541	12	283	5825
17-Dec	211	283	0	5656	0	5868	13	283	6151
24-Dec	106	283	0	5849	0	5954	13	283	6237
31-Dec	0	283	0	5534	0	5534	12	283	5817
Maximum	4257	283	1174	9493	0	11865	26	1174	12930

SITE LAYOUTS

Walla Walla - Touchet spring chinook site layouts are depicted on the following figures.

PRELIMINARY COST ESTIMATES

Preliminary cost estimates (+50% -30%) for the Walla Walla - Touchet spring chinook program are shown on Tables 49 through 50.

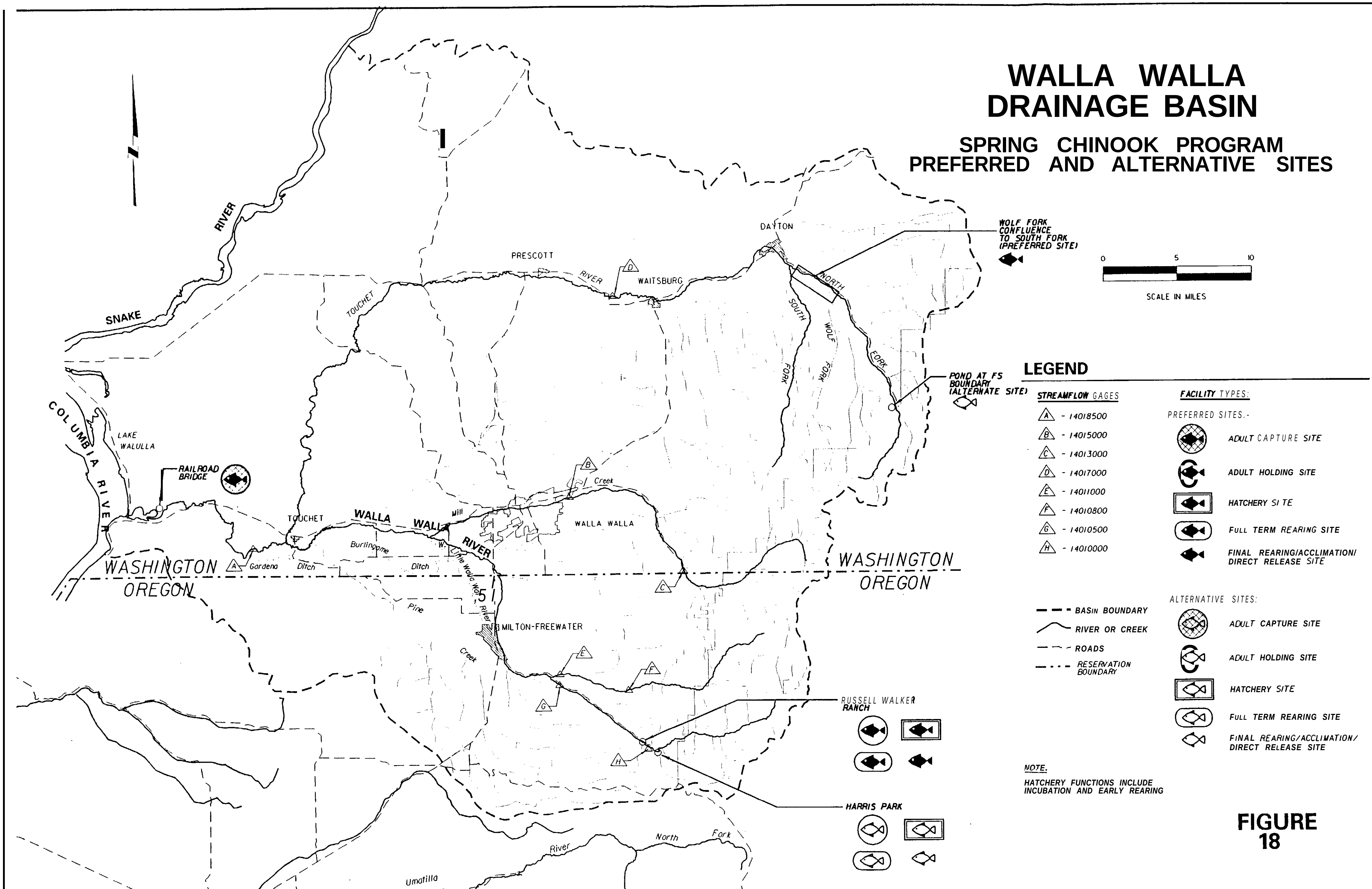
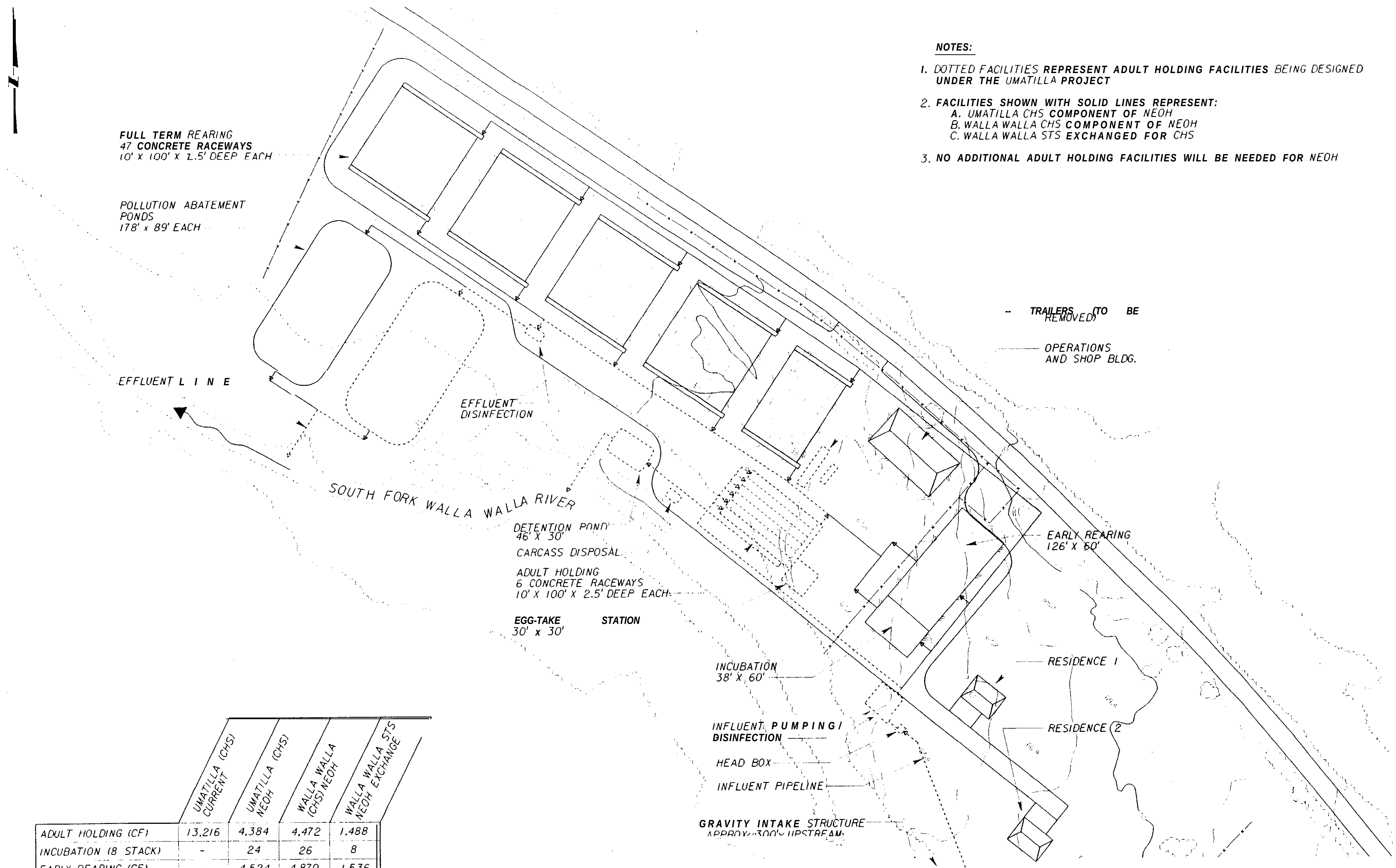

WALLA WALLA
DRAINAGE BASIN
SPRING CHINOOK PROGRAM
PREFERRED AND ALTERNATIVE SITES
WOLF FORK CONFLUENCE TO SOUTH FORK (PREFERRED SITE)
0 5 10
SCALE IN MILES
POND AT FS BOUNDARY (ALTERNATE SITE)
LEGEND
STREAMFLOW GAGES
A - 14018500
B - 14015000
C - 14013000
D - 14017000
E - 14011000
F - 14010800
G - 14010500
H - 14010000
FACILITY TYPES:
PREFERRED SITES:
ADULT CAPTURE SITE
ADULT HOLDING SITE
HATCHERY SITE
FULL TERM REARING SITE
FINAL REARING/ACCLIMATION/ DIRECT RELEASE SITE
ALTERNATIVE SITES:
ADULT CAPTURE SITE
ADULT HOLDING SITE
HATCHERY SITE
FULL TERM REARING SITE
FINAL REARING/ACCLIMATION/ DIRECT RELEASE SITE
BASIN BOUNDARY
RIVER OR CREEK
ROADS
RESERVATION BOUNDARY
NOTE.
HATCHERY FUNCTIONS INCLUDE INCUBATION AND EARLY REARING
RUSSELL WALKER RANCH
HARRIS PARK
RAILROAD BRIDGE
SNAKE RIVER
COLUMBIA RIVER
LAKE WALULLA
DAYTON
PRESCOTT
WAITSBURG
TOUCHET
WALLA WALLA RIVER
WALLA WALLA
MILTON-FREEWATER
WASHINGTON
OREGON
NORTH FORK
SOUTH FORK
WOLF FORK
Mill Creek
Burlingame Ditch
Gardena Ditch
Pine Creek
Little Walla Walla River
Umatilla River North Fork

FIGURE 18



NOTES:

1. DOTTED FACILITIES REPRESENT ADULT HOLDING FACILITIES BEING DESIGNED UNDER THE UMATILLA PROJECT
2. FACILITIES SHOWN WITH SOLID LINES REPRESENT:
   A. UMATILLA CHS COMPONENT OF NEOH
   B. WALLA WALLA CHS COMPONENT OF NEOH
   C. WALLA WALLA STS EXCHANGED FOR CHS
3. NO ADDITIONAL ADULT HOLDING FACILITIES WILL BE NEEDED FOR NEOH

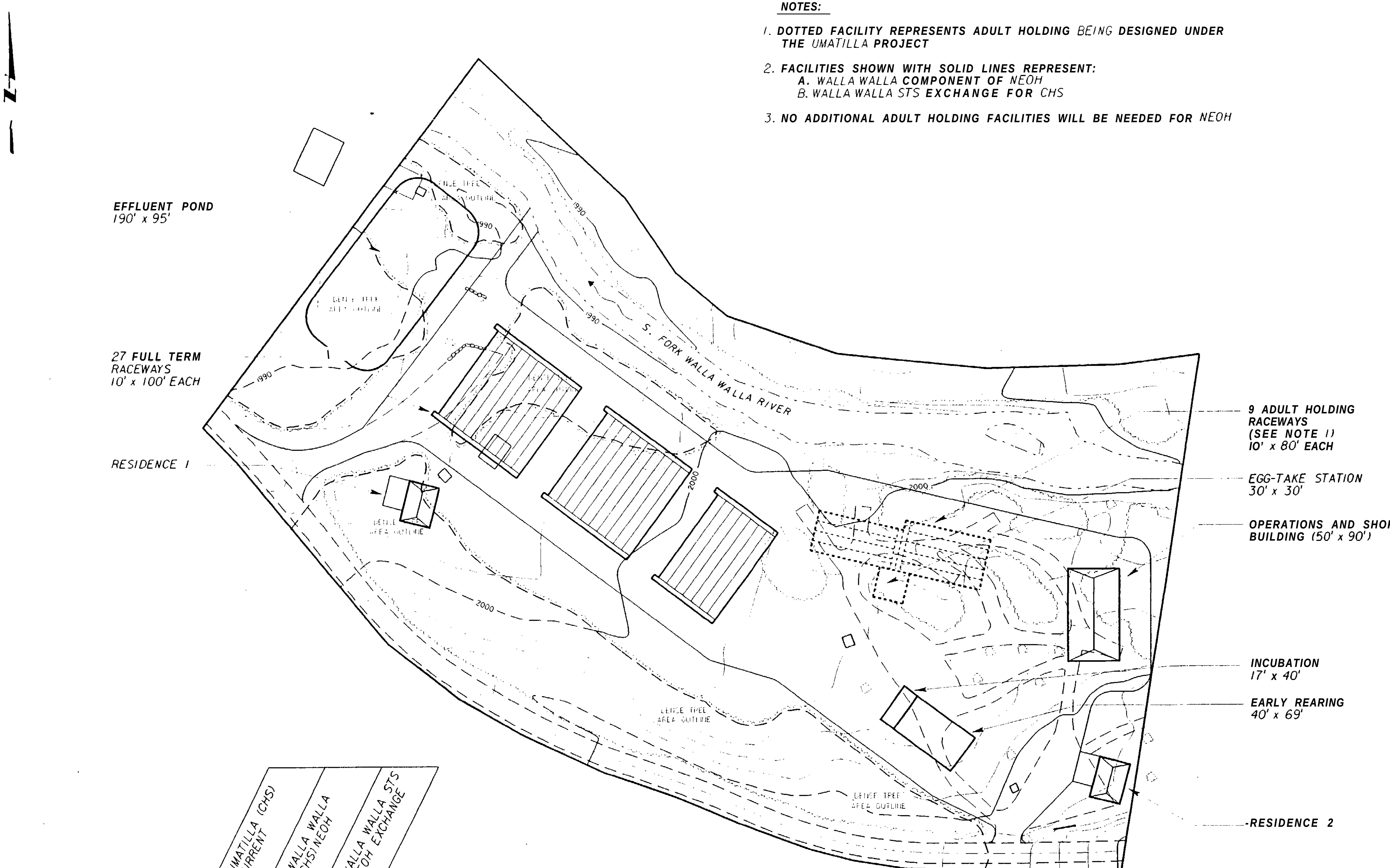
	UMATILLA (CHS) CURRENT	UMATILLA (CHS) NEOH	WALLA WALLA (CHS) NEOH	WALLA WALLA STS NEOH EXCHANGE
ADULT HOLDING (CF)	13,216	4,384	4,472	1,488
INCUBATION (8 STACK)	-	24	26	8
EARLY REARING (CF)	-	4,524	4,870	1,536
FULL TERM REARING (CF)	-	46,872	50,449	15,917

SCALE: 1" = 100'

MONTGOMERY WATSON
Bellevue, Washington

BONNEVILLE POWER ADMINISTRATION
NORTHEAST OREGON HATCHERY PROJECT
SOUTH FORK WALLA WALLA
SPRING CHINOOK SATELLITE FACILITY

FIGURE: 19



NOTES:

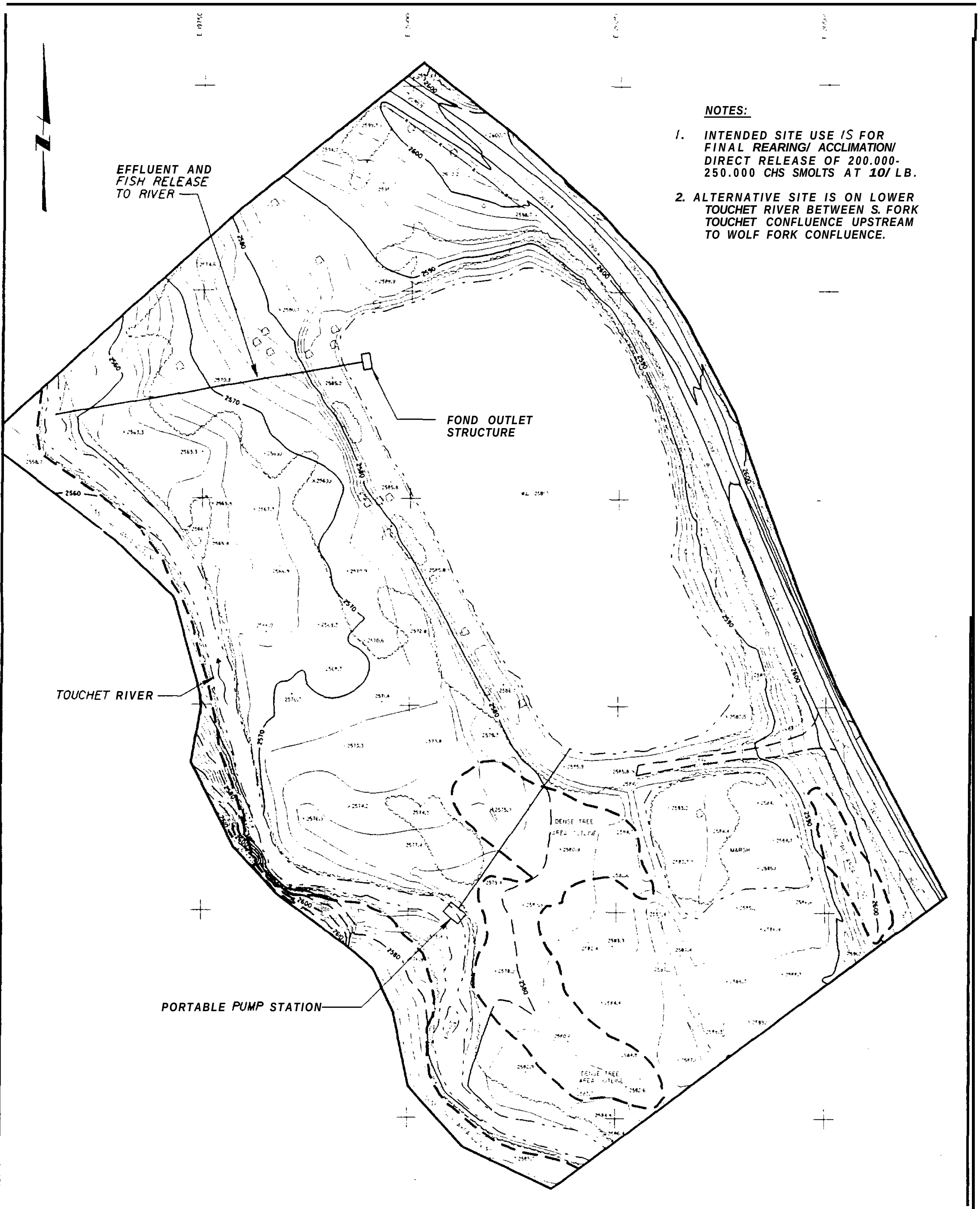
1. DOTTED FACILITY REPRESENTS ADULT HOLDING BEING DESIGNED UNDER THE UMATILLA PROJECT
2. FACILITIES SHOWN WITH SOLID LINES REPRESENT:
   A. WALLA WALLA COMPONENT OF NEOH
   B. WALLA WALLA STS EXCHANGE FOR CHS
3. NO ADDITIONAL ADULT HOLDING FACILITIES WILL BE NEEDED FOR NEOH

	UMATILLA (CHS) CURRENT	WALLA WALLA (CHS) NEOH	WALLA WALLA STS NEOH EXCHANGE
ADULT HOLDING (CF)	13,216	4,472	1,488
INCUBATION (8 STACK)	-	26	8
EARLY REARING (CF)	-	4,870	1,536
FULL-TERM REARING (CF)	-	50,449	15,917

HARISPRK.DGN

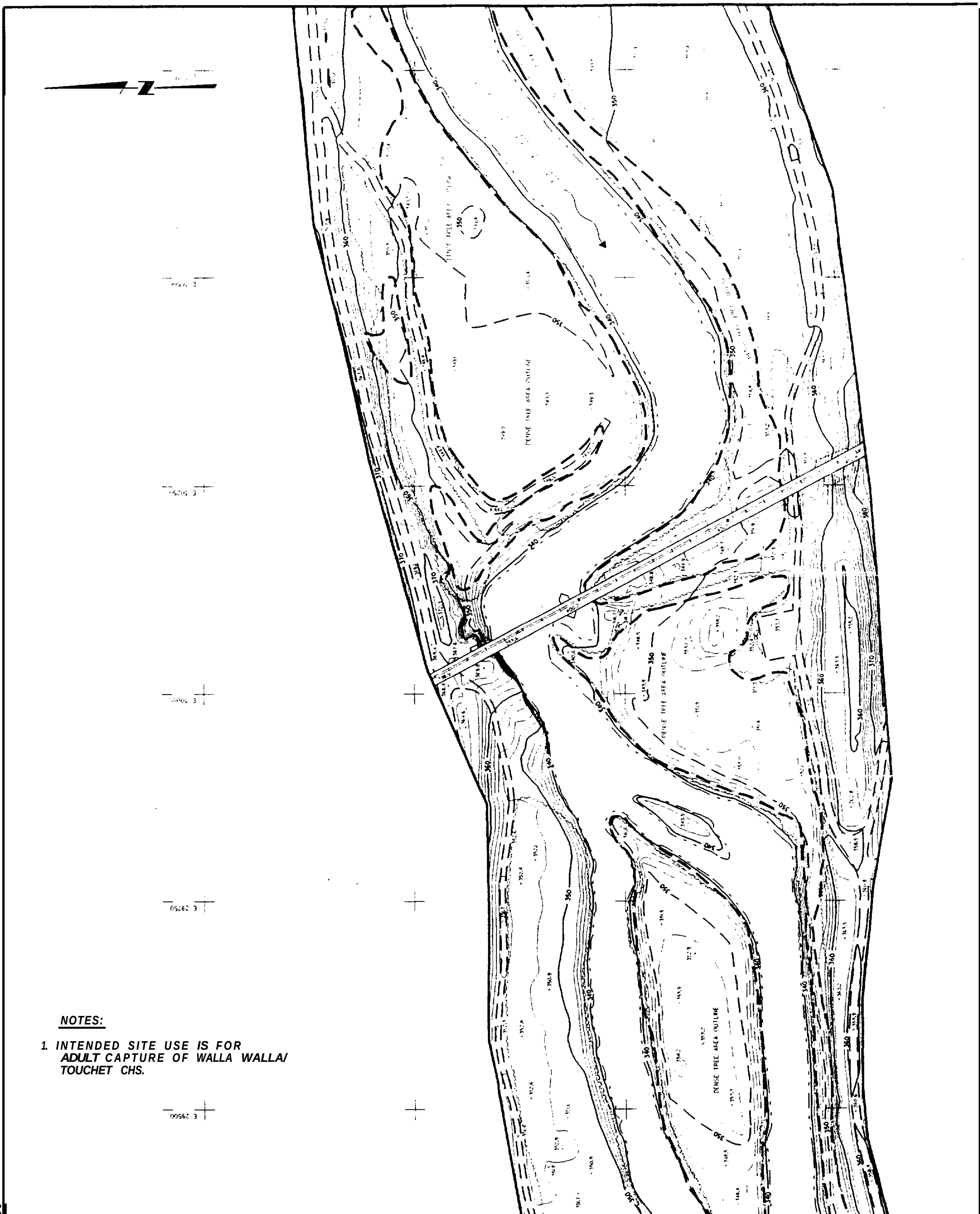
NOVEMBER, 1994

SCALE:			FIGURE:
1"=100'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT HARRIS PARK SITE – S. FORK WALLA WALLA SPRING CHINOOK HATCHERY	20



NOVEMBER 1994

SCALE:			FIGURE:
1"=150'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT POND AT F.S. BOUNDARY-TOUCHET RIVER ACCLIMATION POND	21



NOTES:

1. *INTENDED SITE USE IS FOR ADULT CAPTURE OF WALLA WALLA/ TOUCHET CHS.*

NOVEMBER, 199

SCALE:	MONTGOMERY WATSON	BONNEVILLE POWER ADMINISTRATION	FIGURE:
1"=150'	Bellevue, Washington	NORTHEAST OREGON HATCHERY PROJECT RAILROAD BRIDGE SITE	22

TABLE 49

BONNEVILLE POWER ADMINISTRATION
HARRIS PARK SITE - S. FORK WALLA WALLA HATCHERY
CONCEPTUAL LEVEL CONSTRUCI'ION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	**Ls**	1	**$55,000**	$55,000	$55,000
SITEWORK:					
Clearing and Grubbing	**AC**	6.00	$1,500	$9,000	
Landscaping	**ls**	1	$5,000	$5,000	
Gravel surfacing (all driving surfaces)	**CY**	3,300	$15	$48,500	
Excavation - deposit on site	**CY**	10.000	$12	$120,000	
Engineered Fill	**CY**	400	$20	$8,000	
Erosion Control (rip-rap)	**CY**	150	$60	$9,000	
Fencing	LF	2,000	$18	S36.000	
Gates	EA	6	$600	$3,600	$240,100
REARING RACEWAYS					
Concrete	CY	1.750	$400	$700,000	
Slide Gates	EA	27	$7,000	$189,000	
Inlet Diffusers	SF	108	$75	$8,100	
Outlet Drain Plates	EA	27	$75	$2,025	
Outlet Pipe Winch & standpipe	EA	27	$800	$21,600	
Handrail	LF	1080	$22	S23.760	
Piping and valves	EA	27	$5,000	$135,000	$ 1,079,485
HATCHERY BUILDING					
bldg is one floor incl. everything w/ii walls except:	SF	3,440	$60	$206,400	
Incubators. 8 stack	EA	24	$950	$22,800	
Rearing troughs, 500 gal ea.	EA	20	$1,600	$32,000	$261,200
HEADTANK					
Cont. and misc. metals	CY	50	$475	$23,750	
piping, valves. weir, railing, and misc.	LS	1	$20,000	$20,000	$43,750
YARD PIPING					
Assume similar to Merwin Hatchery	LS	1	$600,000	$600,000	$600,000
OPERATIONS BUILDING building is one floor w/feed room, garage. offices, lab. incl. everything w/in walls	SF	4,500	$68	$306.000	$306,000
RESIDENCES					
two 3 bdr houses, 1400 sf living area	SF	2,800	$62	$173,600	
two 400 sf garages	SF	800	$38	$30,400	$204,000
EFFLUENT POND					
Earthwork	covered above under "sitework"				
Underdrain piping system	LF	550	$20	$11,000	
Subgrade	SY	2,000	$5	$10.000	
Asphalt Lining	SY	2,000	$10	$20,000	

BONNEVILLE POWER ADMINISTRATION
HARRIS PARK SITE - S. FORK WALLA WALLA HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
Hydraulic structures	LS	1	$8,000	$8,000	$49,000
INTAKE STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	50	$475	$23,750	
Misc. metals	LS	1	$4,500	$4,500	
Wedgewire screen	SF	350	$90	$31,500	
Sluice gate	EA	1	$3,000	$3,000	
Automatic screen cleaner	EA	1	$70,000	$70,000	
Baffles	LS	1	$5,000	$5,000	
Stoplogs	LS	1	$9,000	$9,000	
Pipe specials	LS	1	$3,000	$3,000	
Dewatering	LS	1	$12,000	$12,000	$161,750
EFFLUENT STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	40	$475	$19,000	
Misc. metals	LS	1	$2,000	$2,000	
Dewatering	LS	1	$5,000	$5,000	$26,000
POTABLE WELL WATER SYSTEM	LS	1	$10,000	$10,000	$10,000
UTILITY WATER PUMP STATION	LS	1	$18,000	$18,000	$18,000
RIVER INTAKE PUMP STATION					
Pump station slab & encase	CY	60	$250	$15,000	
Pumps	EA	4	$30,000	$120,000	
Flow meter w/ vault	EA	1	$7,500	$7,500	
Valves	LS	1	$15,000	$15,000	
Piping	EA	1	$15,000	$15,000	
Protective Coatings	EA	1	$5,000	$5,000	
Pump Panel	EA	1	$50,000	$50,000	
Controls (basic)	EA	1	$7,500	$7,500	$235,000
ELECTRICAL (7% of subtotal)	LS	1	$253,000	$253,000	$253,000
INSTRUMENTATION (0.5% of subtotal)	LS	1	$18,000	$18,000	$18,000
				SUBTOTAL	$3,560,285
				ESTIMATING CONTINGENCY (25%)	$890,071
				CONTRACTORS OH & PROFIT (20%)	$712,057
				TOTAL CONSTRUCTION COST (12/94)	$5,162,413

TABLE 50

BONNEVILLE POWER ADMINISTRATION
POND AT F.S. BOUNDARY ACCLIMATION POND
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS			$5,000	$5,000
SITEWORK:					
Clearing and Grubbing	AC	1	$1,500	$1,500	
Cut (assumed)	CY	100	$15	$1,500	
Fill (assumed)	CY	100	$15	$1,500	
Rock excavation (assumed)	CY	15	$70	$1,050	
Erosion Control (rip-rap)	CY	30	MO	$1,200	
gravel access roads (to river)	CY	300	$15	$4,500	$11,250
YARD PIPING	LF	700	$50	$35,000	$35,000
RIVER INTAKE STRUCTURE	LS	1	$9,000	$9,000	
Dewatcring	LS	1	$4,000	$4,000	
RIVER OUTLET STRUCTURE	LS	1	$4,000	$4,000	
Dewatering	LS	1	$33,000	$2,000	$19,000
POND INLET HEADER	LS	1	$3,000	$3,000	
POND OUTLET STRUCTURE	LS	1	$5,000	$5,000	**$8,000**
PORTABLE PUMP SYSTEMS	LS	2	$6,000	$12,000	$12,000
				SUBTOTAL	$90,250
				ESTIMATING CONTINGENCY (25%)	$22,563
				CONTRACTORS OH & PROFIT (20%)	$18,050
				TOTAL CONSTRUCTION COST (12/94)	**$130,863**

SITE LAYOUTS FOR GRANDE RONDE

FALL CHINOOK PROGRAM

INTRODUCTION

This section presents the site layouts of the facilities required for the Grande Ronde Fall Chinook Program. These facilities and the preferred / alternative sites were listed in Table 18. Preferred sites for all production phases except adult capture are located within the lower Grande Ronde subbasin (Figure 23). Alternative production sites are also located within the Grande Ronde basin.

Initial use of Wenatchee fall chinook stock (October spawners) is preferred to rebuild this run. The preferred site for adult capture is at an existing capture facility for Wenatchee broodstock. If Wenatchee broodstock cannot be used, a Snake River fall chinook stock is the alternative with adult capture at an existing facility located at one of the Snake River dams. Development of the site plan for the preferred hatchery site will include provisions for an adult trap to be used in the future as the returns increase.

Planning for final rearing / acclimation / direct release sites has been done at three sites:

- a standard rearing pond located at the production facility near the confluence near the confluence of the Minam and Wallowa Rivers,

- improvement of a natural side channel at Flora Grade near Troy, and

- use of an existing LSRCP steelhead acclimation pond on the lower Grande Ronde at Cottonwood Creek. A Grande Ronde River water supply would need to be developed at this site.

Facility layouts for these three sites are currently sized to each accept approximately l/3 of the fall chinook production.

MAXIMUM FACILITY REQUIREMENTS

Table 51 lists the maximum facility requirements for water supply (gpm) and volume (cf) required for the Grande Ronde fall chinook program. The proposed layout to meet these requirements is also listed. The following drawings present a proposed site layout, emphasizing the ability of the preferred site to meet the space requirements. The final layout of the facilities at a site may differ from that shown in these drawings.

TABLE 51

MAXIMUM FACILITY REQUIREMENTS

GRANDE RONDE FALL CHINOOK

Facility	Site	Water Supply (gpm)	Volume (cuft	Proposed Layout
Incubation	Minam - Wallowa confluence	300	1,800,OOO eggs	50 stacks of 8 trays/stack
Early Rearing	Minam - Wallowa confluence	1,817	2,968	124 fry troughs each 2O'x2.5'x1.25' deep
Adult Holding/ Spawning	Minam - Wallowa confluence	328	4,480	Adult Raceways
Full Term Rearing	Minam - Wallowa confluence	5,886	41,587	2 Ponds or 2 raceways
Final Rearing	Flora Grade	1,883	16,161	side channel
	Cottonwood Ck.	1,867	16,161	existing pond
	Minam-Wallowa	2,819	23,307	pond

PRODUCTION TIMING AND TEMPERATURE CONSIDERATIONS

The temperature data for the Grande Ronde Fall Chinook program is based on the temperature from the Minam USGS station, Temperature criteria consideration for the site based on the use of surface water for all phases is presented in the Table 52 for comparison of sites. During September, the surface water is slightly higher than the temperature criteria for adult holding. A small amount of heating is needed for incubation if surface water is used. It is estimated that 1500-2500 gpm of 70 °F groundwater could be developed at this site.

Based on the production goals and growth rates presented in Table 5, four growth models were simulated:

TABLE 52

INFLUENCE OF WATER SOURCE ON GROWTH RATE

GRANDE RONDE FALL CHINOOK

Water Source	Actual Release Date @ 40/lb	Actual Release Date @ 50/lb	Desired Release Date	Comments
GW for Incubation and Early Rearing SW for Rearing	July 14	June 30	March - May 15	Both heating and cooling required
SW for incubation, Early Rearing, and Rearing	September 8	August 25	March - May 15	Both heating and cooling required

GW = groundwater
SW = surface water or groundwater adjusted to the local surface water temperature

If groundwater is used for incubation, the water will have to be chilled by 15-20 °F. The use of disinfected surface water slows the growth down significantly. It may be possible to use the surface water to chill the groundwater. Additional groundwater will needed to increase water temperature during the February to May to increase the growth of the fish. Both surface and groundwater will be needed to make this site work.

Relative heating and cooling requirements are shown on Table 53.

TABLE 53

COMPARISON OF ACTUAL TEMPERATURES, TEMPERATURE CRITERIA, AND DEGREE OF REQUIRED HEATING OR COOLING

Fall Chinook - Wallowa River below Minam Confluence

	Actual Temperature (°F)			Temperature Criteria (°F)				Required ΔT (°F)		
Month	10 % of Daily Min.	Mean of Daily Avg.	75 % of Daily Max.	Max Adult Holding	Min Incub	Max Incub	Max Rearing	Adult Holding	Incub	Rearing
Oct	36.0	45.5	52.6							
Nov	32.0	36.4	41.9							
Dec	32.0	33.4	36.0							
Jan	32.0	33.2	36.0							
Feb	32.0	34.3	39.5							
Mar	32.2	38.2	44.1							
Apr	36.0	42.1	48.9							
May	39.2	44.3	50.0							
Jun	41.5	47.1	52.7							
Jul	46.6	57.7	69.0							
Aug	52.7	63.7	72.9							
Sep	44.1	56.2	66.2	63				-3.2		
Oct	36.0	45.5	52.6	63	38	60			+2.0	
Nov	32.0	36.4	41.9	63	38	60			+6.0	
Dec	32.0	33.4	36.0	63	38	60			+6.0	
Jan	32.0	33.2	36.0		38	60	63		+6.0	
Feb	32.0	34.3	39.5		38	60	63		+6.0	
Mar	32.2	38.2	44.1				63			
Apr	36.0	42.1	48.9				63			
May	39.2	44.3	50.0				63			
Jun	41.5	47.1	52.7							
Jul	46.6	57.7	69.0							
Aug	52.7	63.7	72.9							
Sep	44.1	56.2	66.2							
Oct	36.0	45.5	52.6							
Nov	32.0	36.4	41.9							
Dec	32.0	33.4	36.0							
Jan	32.0	33.2	36.0							
Feb	32.0	34.3	39.5							
Mar	32.2	38.2	44.1							
Apr	36.0	42.1	48.9							
May	39.2	44.3	50.0							
Jun	41.5	47.1	52.7							
Jul	46.6	57.7	69.0							
Aug	52.7	63.7	72.9							
Sep	44.1	56.2	66.2							

TABLE 54

REQUIRED FLOWS
MINAM-WALLOWA CONFLUENCE

		Adult Holding Surface Water Flow (gpm)	Incubation Groundwater flow (gpm)	Early Rearing Groundwater flow (gpm)	Rearing Surface Water Flow (gpm)	Total Surface Flow (gpm)	Total GW Flow &pm)	Total Water Flow (gpm)
Week	Date							
0	1 -Jan	0	192			0	192	192
1	8-Jan	0	192			0	192	192
2	15-Jan	0		484		0	484	484
3	22-Jan	0		579		0	579	579
4	29-Jan	0		681		0	681	681
5	5-Feb	0		791		0	791	791
6	12-Feb	0		908		0	908	908
7	19-Feb	0		1032		0	1032	1032
8	26-Feb	0		1163		0	1163	1163
9	5-Mar	0			815	815	0	815
10	12-Mar	0			849	849	0	849
11	19-Marl	0			902	902	0	902
12	26-Mar	0			946	946	0	946
13	2-Apr	0			1011	1011	0	1011
14	9-Apr	0			1088	1088	0	1088
15	16-Apr	0			1144	1144	0	1144
16	23-Apr	0			1237	1237	0	1237
17	30-Apr	0			1335	1335	0	1335
18	7-May	0			1419	1419	0	1419
19	14-May	0			1488	1488	0	1488
20	21-May	0			1578	1578	0	1578
21	28-May	0			1655	1655	0	1655
22	4-Jun	0			1864	1864	0	1864
23	11-Jun	0			2015	2015	0	2015
24	18-Jun	0				0	0	0
25	25-Jun	0				0	0	0
26	2-Jul	0				0	0	0
27	9-Jul	0				0	0	0
28	16-Jul	0				0	0	0
29	23-Jul	0				0	0	0
30	30-Jul	0				0	0	0
31	6-Aug	0				0	0	0
32	13-Aug	0				0	0	0
33	20-Aug	0				0	0	0
34	27-Aug	0				0	0	0
35	3-Sep	9				9	0	9
36	10-Sep	23				23	0	23
37	17-Sep	51				51	0	51
38	24-Sep	112				112	0	112
39	1-Oct	215				215	0	215
40	8-Oct	307				307	0	307
41	15-Oct	328	192			328	192	520
42	22-Oct	318	192			318	192	510
43	29-Oct	324	192			324	192	516
44	5-Nov	264	192			264	192	456
45	12-Nov	178	192			178	192	370
46	19-Nov	108	192			108	192	300
47	26-Nov	73	192			73	192	265
48	3-Dec	73	192			73	192	265
49	10-Dec	49	192			49	192	241
50	17-Dec	41	192			41	192	233
51	24-Dec	23	192			23	192	215
52	31-Dec	0	192			0	192	192
	Maximum	328		1163	2015	2015	1163	2015

SITE LAYOUTS

Grande Ronde fall chinook site layouts are depicted on the following figures.

PRELIMINARY COST ESTIMATES

Preliminary cost estimates (+50%, -35%) for the Grande Ronde drainage basin fall chinook site layouts are shown on Tables 55 through 57.

GRANDE RONDE DRAINAGE BASIN

GRANDE RONDE FALL CHINOOK PROGRAM PREFERRED AND ALTERNATIVE SITES

LEGEND

FACILITY TYPES:

PREFERRED SITES:

- ADULT CAPTURE SITE
- ADULT HOLDING SITE
- HATCHER?' SITE
- FULL TERM REARING SITE
- FINAL REARING/ACCLIMATION/ DIRECT RELEASE SITE

ALTERNATIVE SITES:

- ADULT CAPTURE SITE
- ADULT HOLDING SITE
- HATCHERY SITE
- FULL TERM REARING SITE
- FINAL REARING/ACCLIMATION/ DIRECT RELEASE SITE

STREAMFLOW GAGES

A	13333000
B	13332500
C	13323500
D	13319000
E	13318800
F	13318500
G	13331500
H	13330500
I	13330000
J	13329500
K	13327500
L	13323600
M	13320000

- BASIN BOUNDARY
- RIVER OR CREEK
- ROADS
- RESERVATION BOUNDARY

NOTES:

1. WENATCHE BROODSTOCK PREFERRED TO REBUILD RUN (TO BE COLLECTED AT WENATCHEE STOCK COLLECTION SITE). ADULT TRAP AT . HATCHERY SITE TO BE DESIGNED FOR FUTURE USE ONCE RUNS ARE REBUILT
2. ADULT HOLDING ALTERNATIVE SITE IS AT EXISTING LYONS FERRY FACILITY
3. HATCHERY FUNCTIONS INCLUDE INCUBATION AND EARLY REARING

0 5 10 20

SCALE IN MILES

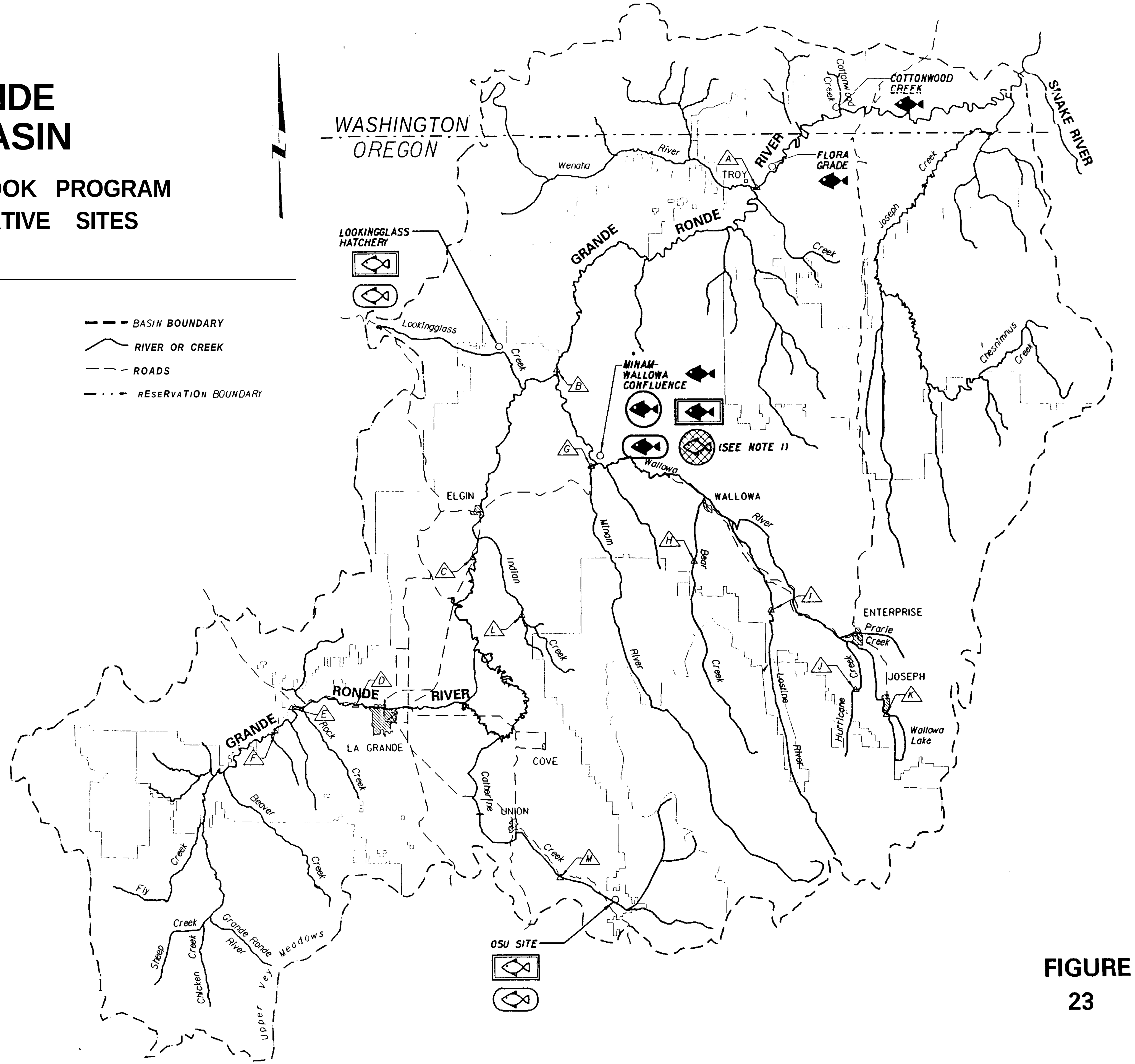
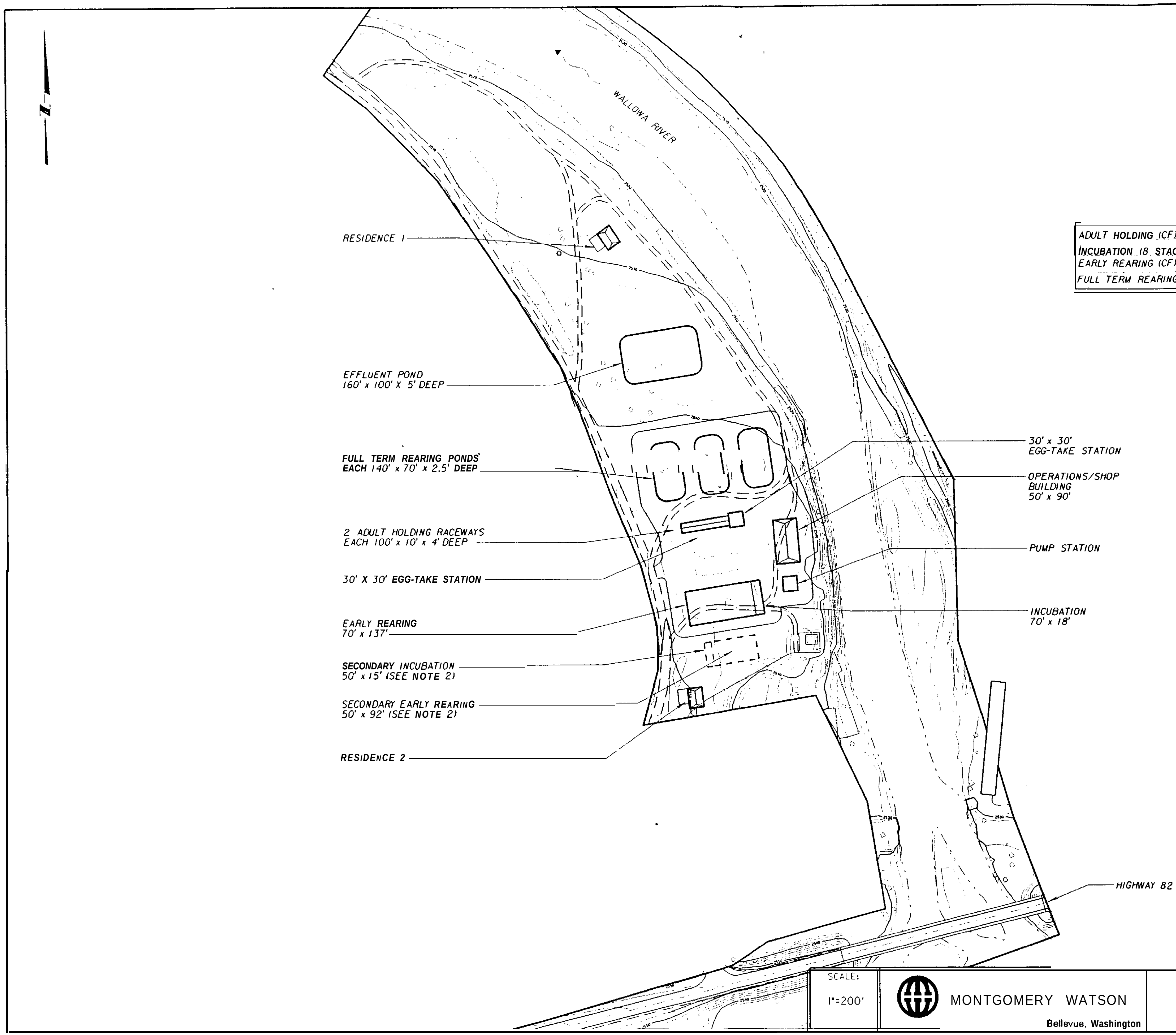


FIGURE 23



	GRANDE RONDE CHF	LOSTINE CHS
ADULT HOLDING (CF)	7,000	0
INCUBATION (8 STACK)	50 •	29
EARLY REARING (CF)	9,892	4,790
FULL TERM REARING (CF)	38,694	0

NOTES:

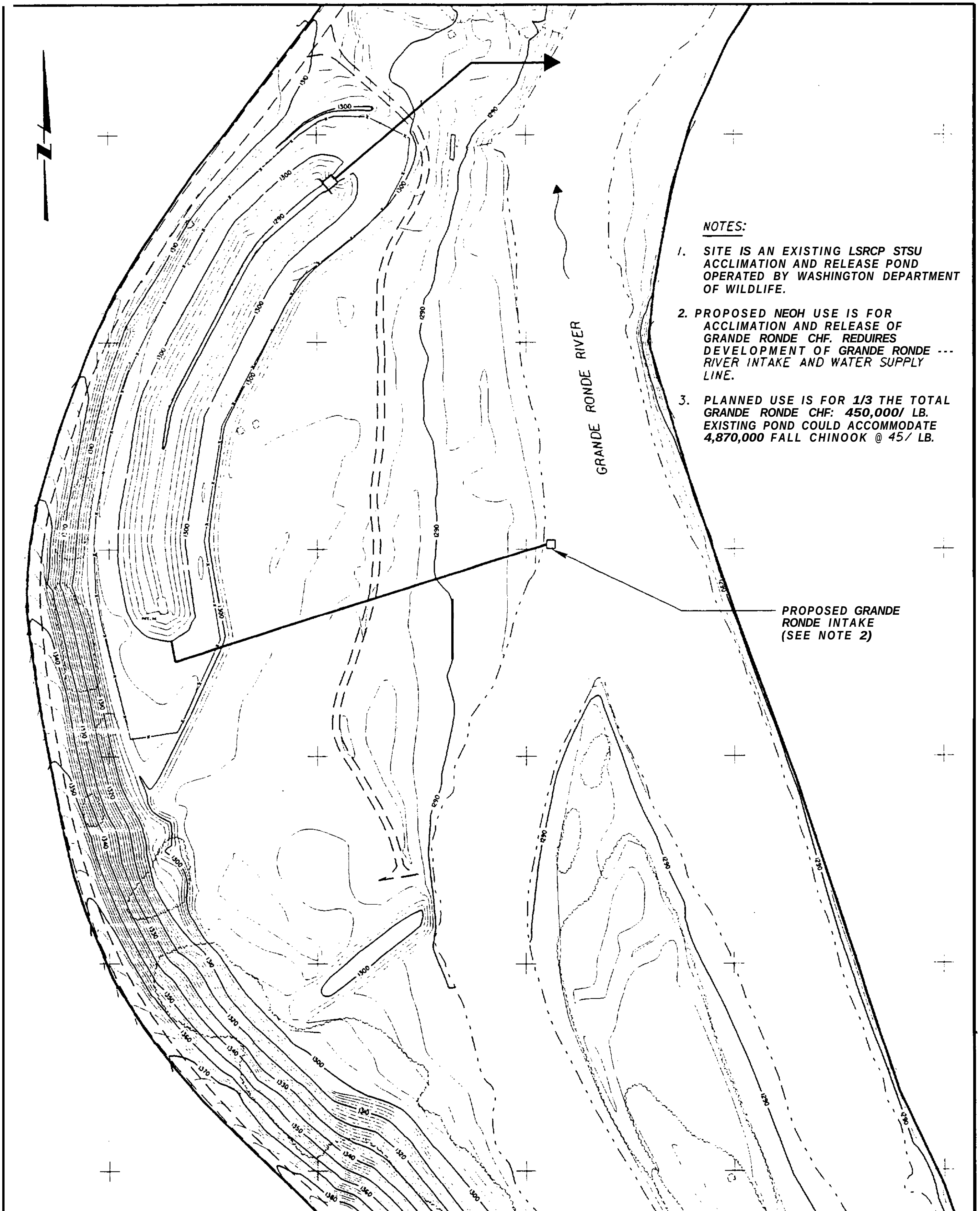
1. FACILITY REQUIREMENTS FOR GRANDE RONDE CHF REPRESENT THE PRIMARY SITE USE.
2. INCLUDED ARE FACILITY REQUIREMENTS FOR INCUBATION AND EARLY REARING OF LOSTINE CHS AS AN ALTERNATIVE AND ADDITIONAL USE OF THIS SITE.
3. ACCLIMATION AND DIRECT RELEASE OF 1/3 THE GRANDE RONDE CHF WILL ALSO OCCUR AT THIS SITE: APPROXIMATELY 450,000 AT 45/ LB.
4. LAYOUT OF FACILITIES IN INTENDED TO SHOW GENERAL SPACE REQUIREMENTS AND DOES NOT REPRESENT FINAL RECOMMENDED CONFIGURATION.

SCALE: 1"=200'

MONTGOMERY WATSON
Bellevue, Washington

BONNEVILLE POWER ADMINISTRATION
NORTHEAST OREGON HATCHERY PROJECT
WALLOWA RIVER BELOW MINAM
FALL CHINOOK HATCHERY

FIGURE: 24



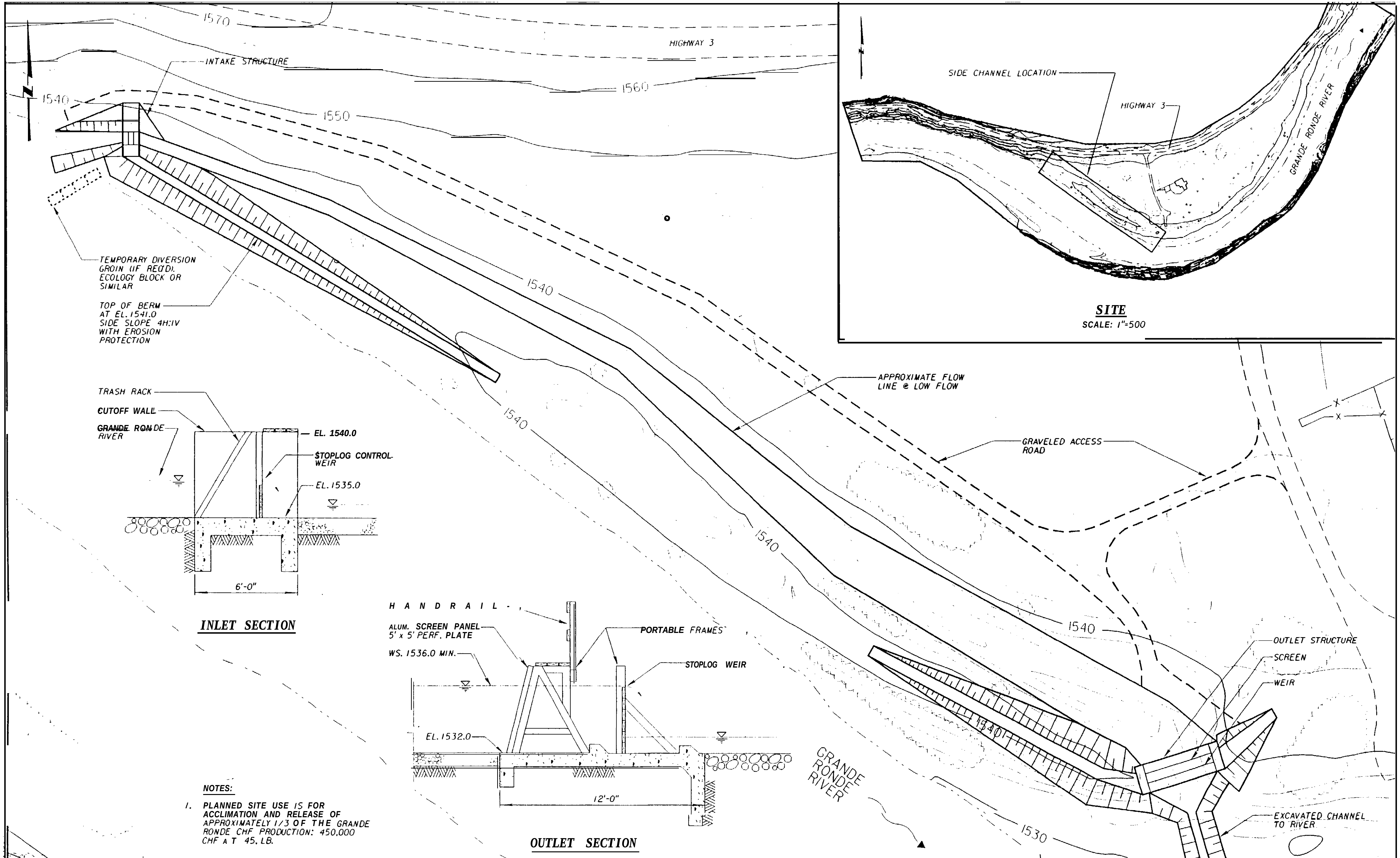
NOTES:

1. SITE IS AN EXISTING LSRCP STSU ACCLIMATION AND RELEASE POND OPERATED BY WASHINGTON DEPARTMENT OF WILDLIFE.

2. PROPOSED NEOH USE IS FOR ACCLIMATION AND RELEASE OF GRANDE RONDE CHF. REDUIRES DEVELOPMENT OF GRANDE RONDE --- RIVER INTAKE AND WATER SUPPLY LINE.

3. PLANNED USE IS FOR 1/3 THE TOTAL GRANDE RONDE CHF: 450,000/ LB. EXISTING POND COULD ACCOMMODATE 4,870,000 FALL CHINOOK @ 45/ LB.

SCALE: 1"=150'	MONTGOMERY WATSON Bellevue. Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT COTTONWOOD CREEK	FIGURE: 25



SCALE: 1"=50'

MONTGOMERY WATSON
Bellevue, Washington

BONNEVILLE POWER ADMINISTRATION
NORTHEAST OREGON HATCHERY PROJECT
FLORA GRADE SITE –
ACCLIMATION CHANNEL

FIGURE: 26

TABLE 55

BONNEVILLE POWER ADMINISTRATION
WALLOWA RIVER BELOW **MINAM** CONFLUENCE HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS	I	$60,000	$60,000	$60,000
SITEWORK:					
Clearing and Grubbing	AC	5.50	$1,500	$8,250	
Landscaping	LS	1	$5,000	$5,000	
Gravel surfacing (all driving surfaces)	CY	2,900	$15	$43,500	
Excavation - deposit on site	CY	8,700	$12	$104,400	
Engineered Fill	CY	4.00	$20	$8,000	
Erosion Control (riprap)	CY	200	$60	$12,000	
Fencing	LF	1.200	$18	$21.600	
Gates	EA	6	$600	$3,600	$206,350
ADULT HOLDING RACEWAYS					
Concrete	CY	160	$450	$72,000	
Slide Gates	EA	2	$10,000	$20,000	
Inlet Diffusers	SF	8	$75	$600	
Outlet Drain Plates	EA	2	$75	$150	
Outlet Pipe Winch & standpipe	EA	2	$800	$1,600	
Handrail	LF	250	$22	$5,500	
Piping and valves	LS	I	$15,000	$15,000	$114,850
EGG-TAKE STATION	SF	900	$120	$108,000	$108,000
HATCHERY BUILDING					
bldg is one floor incl. everything w/ii walls except	SF	11,000	$55	$605,000	
Incubators. 8 stack	EA	50	$950	$47,500	
Rearing troughs, 500 gal ea.	EA	160	$1,600	$256,000	$908,500
HEADTANK					
Cont. and misc. metals	CY	50	$475	$23.750	
piping, valves, weir, railing, and misc.	LS	1	$20,000	$20,000	$43,750
YARD PIPING					
Assume similar to Merwin Hatchery	LS	1	$400,000	$400,000	$400,000
OPERATIONS BUILDING building is one floor w/feed room, garage, offices, lab. incl. everything w/in walls	SF	4,500	$68	$306,000	$306,000
RESIDENCES					
two 3 bdr houses, 1400 sf living area	SF	2,800	$62	$173,600	
two 400 sf garages	SF	800	$38	$30,400	$204,000
REARING PONDS (3)					
Earthwork	covered above under "sitework"				
Underdrain piping system	LF	1,050	$20	$21,000	
Subgrade	SY	3,400	$5	$17,000	
Asphalt Lining	SY	3.400	$10	$34,000	
Birdnetting (on posts)	SF	30,600	$3	$91,800	
Hydraulic structures	EA	3	Sl0.000	$30,000	s193,800
EFFLUENT POND					
Earthwork	covered above under "sitework"				
Underdrain piping system	LF	550	$20	$11,000	
Subgrade	SY	1,900	$5	$9,500	
Asphalt Lining	SY	1,900	$10	$19,000	

TABLE 55

BONNEVILLE POWER ADMINISTRATION
WALLOWA RIVER BELOW MINAM CONFLUENCE HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	S/Unit	Total	Category Total
Hydraulic structures	EA	1	$8,000	$8,000	$47,500
CARCASS DISPOSAL	LS	1	$30,000	$30,000	$30,000
INTAKE STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	50	$475	$23,750	
Misc. metals	LS	1	$4,500	$4,500	
Wedgewire screen	SF	350	SW	$31,500	
Sluice gate	EA	1	$3,000	$3,000	
Automatic screen cleaner	EA	1	$70,000	$70,000	
Baffles	LS	1	$5,000	$5,000	
Stoplogs	LS	1	$9,000	$9,000	
Pipe specials	LS	1	$3,000	$3,000	
Dewatcring	LS	1	$12.000	$12,000	$161,750
EFFLUENT STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	40	$475	$19,000	
Misc. metals	LS	1	$2,000	$2,000	
Dewatering	LS	1	$5,000	$5,000	$26,000
POTABLE WELL WATER SYSTEM	LS	1	$10,000	$10,000	$10,000
UTILITY WATER PUMP STATION	LS	1	$18,000	$18,000	$18,000
RIVER INTAKE PUMP STATION	(for hatchery bldg. only)				
pump station slab & encase	CY	60	$250	$15,000	
Pumps	EA	4	$30,000	$120,000	
Flow meter w/vault	EA	1	$7,500	$7,500	
Valves	LS	1	$15,000	$15,000	
Piping	EA	1	$15,000	$15,000	
protective Coatings	EA	1	$5,000	$5,000	
Pump Panel	EA	1	$50,000	$50,000	
Controls (basic)	EA	1	$7,500	$7,500	$235,000
ELECTRICAL (7% of subtotal)	LS	1	$232,600	$232,600	$232,600
INSTRUMENTATION (0.5% of subtotal)	LS	1	$16,600	$16,600	$16,600
				SUBTOTAL	$3,322,700
				ESTIMATING CONTINGENCY (25%)	$830,675
				CONTRACTORS OH & PROFIT (20%)	$664,540
				TOTAL **CONSTRUCTION COST (12/94)**	**$4,817,915**

TABLE 56

BONNEVILLE POWER ADMINISTRATION
COTTONWOOD CREEK ACCLIMATION FACILITY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS			$7,500	$7,500
SITEWORK:					
Clearing **and** Grubbing	AC	1	$1,500	$1,500	
cut	CY	100	$15	$1,500	
Fill	CY	100	$15	$1,500	
Rock excavation (assumed)	CY	15	$70	$1,050	
Erosion Control (rip-rap)	CY	30	$40	$1,200	
gravel **access** roads (to river)	CY	330	$15	$4,950	$11,700
YARD PIPING	LF	800	$45	$36,000	
fittings	LS	1	$8,000	$8,000	$44,000
INTAKE STRUCTURE	LS		$15,000	$15,000	
Dewatering	LS	1	$5,000	$5,000	$20,000
OUTLET STRUCTURE	LS	1	$10,000	$10,000	
Dewatering	LS		$2,500	$2,500	$12,500
PORTABLE PUMP SYSTEMS	**LS**	2	$6,000	$12,000	$12,000
				SUBTOTAL	$107,700
				ESTIMATING CONTINGENCY (25%)	$26,925
				CONTRACTORS OH & PROFIT (20%)	$2 1,540
				TOTAL CONSTRUCTION COST (12/94)	**$156,165**

TABLE 57

BONNEVILLE POWER ADMINISTRATION
FLORA GRADE ACCLIMATION FACILITY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS			$7,500	$7,500
SITEWORK:					
Clearing and Grubbing	AC	7	$1,500	$10,500	
Landscaping	LS	1	$2,000	$2,000	
Access Road (gravel)	CY	990	$15	$14,850	
cut	CY	1,000	$15	$15,000	
Fill	CY	200	$15	$3,000	
Rock excavation (assumed)	CY	15	$70	$1,050	
Erosion Control (rip-rap)	CY	30	$40	$1,200	$47,600
ACCLIMATION CHANNEL					
Gravel	CY	850	$15	$12,750	
Birdnetting (staked to ground)	SF	15,000	$1.50	$22,500	
Inlet structure	LS	1	$15.000	$15,000	
Outlet structure	LS	1	$10,000	$10,000	
Dew atering	LS	1	$12,000	$12,000	$72,250
ELECTRICAL/INSTRUMENTATION (assume trailer power req'd)	LS	1	$15,000	$15,000	$15.000
				SUBTOTAL	$142,350
				ESTIMATING CONTINGENCY (25%)	$35,588
				CONTRACTORS OH & PROFIT (20%)	$28,470
				TOTAL CONSTRUCTION COST (12/94)	$206,408

SITE LAYOUTS FOR IMNAHA

FALL CHINOOK PROGRAM

INTRODUCTION

This section presents the site layouts of the facilities required for the Imnaha Fall Chinook Program. These facilities and the preferred / alternative sites were listed in Table 19. Preferred sites for all production phases except adult capture and holding are located within the Imnaha subbasin at the Gene Marr Ranch (Figure 27).

Initial use of Lyons Ferry , or other suitable Snake River fall chinook stock (November spawners) is preferred to rebuild this run. The preferred site for adult capture is at an existing capture facility at one of the Snake River dams. Development of the site plan for the preferred hatchery site will include provisions for an adult trap to be used in the future as the returns increase.

Falls Creek springs is currently planned as the water source for incubation and early rearing.

MAXIMUM FACILITY REQUIREMENTS

Table 58 lists the maximum facility requirements for water supply (gpm) and volume (cf) required for the Imnaha fall chinook program. The proposed layout to meet these requirements is also listed. The following drawings present a proposed site layout, emphasizing the ability of the preferred site to meet the space requirements. The final layout of the facilities at a site may differ from that shown in these drawings.

TABLE 58

MAXIMUM FACILITY REQUIREMENTS

IMNAHA FALL CHINOOK

Facility	Site	Water Supply (gpm)	Volume (cuft)	Proposed Layout
Incubation	Gene Marr Ranch	23	139,860 eggs	4 stacks of 8 trays/stack
Early Rearing	Gene Marr Ranch	136	231	4 fry troughs each 2O’x2.5’xl.25’ deep
Adult Holding/ Spawning	Lyons Ferry (existing facility)	46	420	Raceway
Full Term Rearing	Gene Marr Ranch	240	2,270	pond
Final Rearing	Gene Marr Ranch	318	4,280	pond or side channel

PRODUCTION TIMING AND TEMPERATURE CONSIDERATIONS

The temperature data for the Imnaha Fall Chinook program is based on the temperature from the Imnaha USGS station. Temperature criteria consideration for the site based on the use of surface water for all phases is presented in Table 59 for comparison of sites. During September, the surface water is higher than the temperature criteria for adult holding. A small amount of heating is needed for incubation if surface water is used.

Based on the production goals and growth rates presented in Table 5, four growth models were simulated:

TABLE 59

INFLUENCE OF WATER SOURCE ON GROWTH RATE

IMNAHA FALL CHINOOK

Water Source	Actual Release Date @ 70/lb	Actual Release Date @ 80/lb	Desired Release Date	Comments
GW for Incubation and Early Rearing SW for Rearing	May 19	May 12	March - May 15	Desired release date is achievable
SW for Incubation, Early Rearing, and Rearing	July 14	July 7	March - May 15	Desired release date is achievable

GW = groundwater
SW = surface water or groundwater adjusted to the local surface water temperature

If groundwater is used for incubation, the water will have to be chilled by 15-20 °F. The use of disinfected surface water slows the growth down significantly. It may be possible to use the surface water to chill the groundwater. Additional groundwater will needed to increase water temperature during the February to May to increase the growth of the fish.

Relative heating and cooling requirements are shown on Table 60.

TABLE 60

COMPARISON OF ACTUAL TEMPERATURES, TEMPERATURE CRITERIA, AND DEGREE OF REQUIRED HEATING OR COOLING

Fall Chinook - Gene Marr Ranch - Imnaha River

	Actual Temperature (°F)			Temperature Criteria (°F)				Required ΔT (°F)		
Month	10 % of Daily Min.	Mean of Daily Avg.	75 % of Daily Max.	Max Adult Holding	Min Incub	Max Incub	Max Rearing	Adult Holding	Incub	Rearing
Oct	42.8	50.3	57.0							
Nov	36.2	42.3	46.2							
Dec	31.6	34.9	38.2							
Jan	31.8	35.6	38.8							
Feb	34.5	41.6	46.3							
Mar	38.5	44.7	49.8							
Apr	41.0	48.1	53.8							
May	43.7	48.7	53.1							
Jun	46.4	53.8	58.6							
Jul	54.8	63.5	71.4							
Aug	58.3	66.0	73.9							
Sep	52.4	61.5	69.4	63				-6.4		
Oct	42.8	50.3	57.0	63	38	60				
Nov	36.2	42.3	46.2	63	38	60			+1.8	
Dec	31.6	34.9	38.2	63	38	60			+6.4	
Jan	31.8	35.6	38.8		38	60	63		+6.4	
Feb	34.5	41.6	46.3		38	60	63		+3.5	
Mar	38.5	44.7	49.8				63			
Apr	41.0	48.1	53.8				63			
May	43.7	48.7	53.1				63			
Jun	46.4	53.8	58.6							
Jul	54.8	63.5	71.4							
Aug	58.3	66.0	73.9							
Sep	52.4	61.5	69.4							
Oct	42.8	50.3	57.0							
Nov	36.2	42.3	46.2							
Dec	31.6	34.9	38.2							
Jan	31.8	35.6	38.8							
Feb	34.5	41.6	46.3							
Mar	38.5	44.7	49.8							
Apr	41.0	48.1	53.8							
May	43.7	48.7	53.1							
Jun	46.4	53.8	58.6							
Jul	54.8	63.5	71.4							
Aug	58.3	66.0	73.9							
Sep	52.4	61.5	69.4							

TABLE 61

REQUIRED FLOWS
GENE MARR RANCH

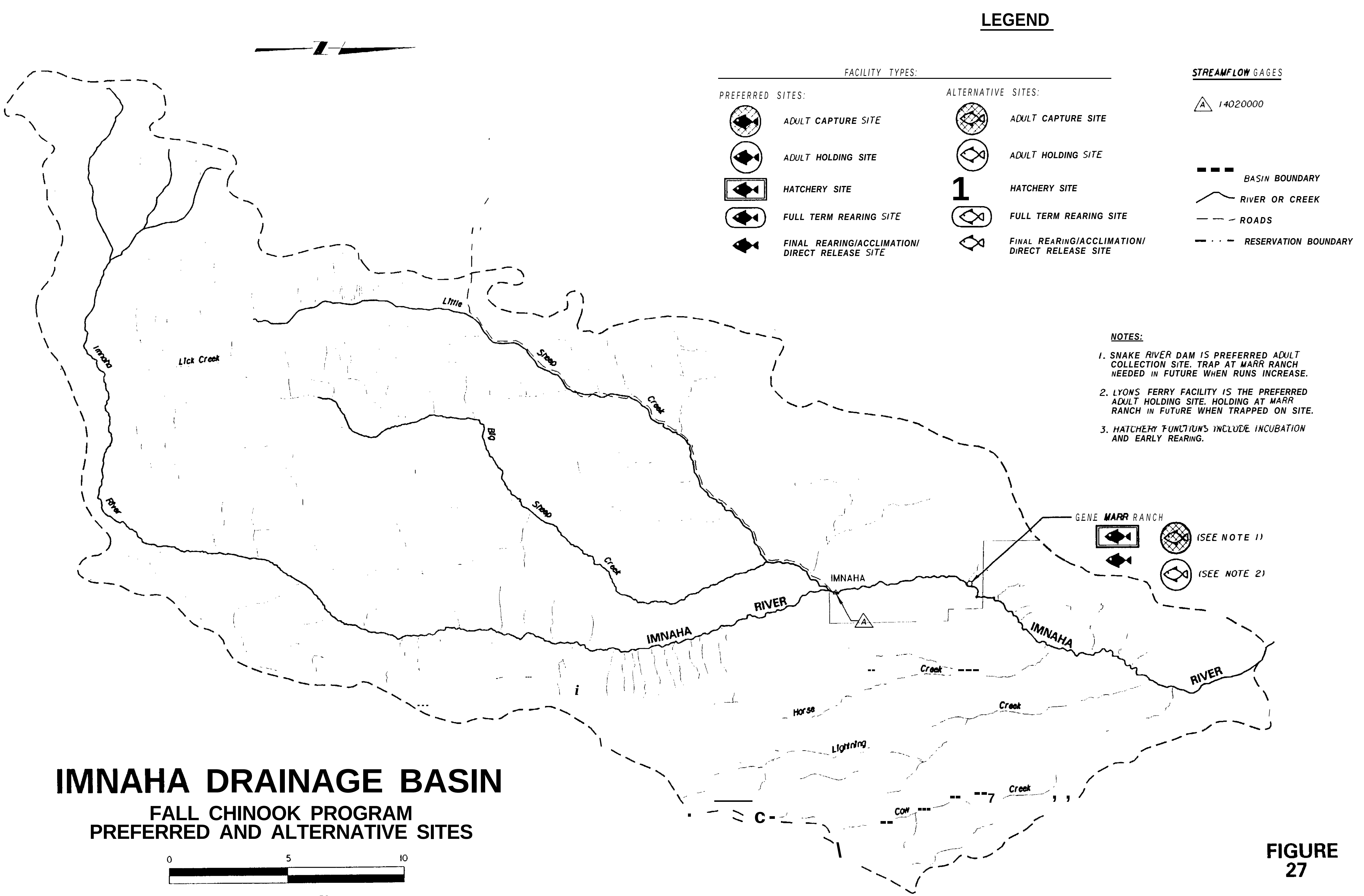
Week	Date	Adult Holding Surface Water Flow (gpm)	Incubation Groundwater flow (gpm)	Early Rearing Groundwater Flow (gpm)	Rearing Surface Water Flow (gpm)	Total Surface flow (gpm)	Total GW flow (gpm)	Total Water Flow (gpm)
0	1 -Jan	0	23			0	23	23
1	8-Jan	0	23			0	23	23
2	15-Jan	0		57		0	57	57
3	22-Jan	0		68		0	68	68
4	29-Jan	0		80		0	80	80
5	5-Feb	0		93		0	93	93
6	12-Feb	0		106		0	106	106
7	19-Feb	0		121		0	121	121
8	26-Feb	0		136		0	136	136
9	5-Mar	0			104	104	0	104
10	12-Mar	0			109	109	0	109
11	19-Mar	0			123	123	0	123
12	26-Mar	0			131	131	0	131
13	2-Apr	0			150	150	0	150
14	9-Apr	0			156	156	0	156
15	16-Apr	0			159	159	0	159
16	23-Apr	0			192	192	0	192
17	30-Apr	0			209	209	0	209
18	7-May	0			225	225	0	225
19	14-May	0			240	240	0	240
20	21-May	0				0	0	0
21	28-May	0				0	0	0
22	4-Jun	0				0	0	0
23	11-Jun	0				0	0	0
24	18-Jun	0				0	0	0
25	25-Jun	0				0	0	0
26	2-Jul	0				0	0	0
27	9-Jul	0				0	0	0
28	16-Jul	0				0	0	0
29	23-Jul	0				0	0	0
30	30-Jul	0				0	0	0
31	6-Aug	0				0	0	0
32	13-Aug	0				0	0	0
33	20-Aug	0				0	0	0
34	27-Aug	0				0	0	0
35	3-Sep	1				1	0	1
36	10-Sep	2				2	0	2
37	17-Sep	5				5	0	5
38	24-Sep	13				13	0	13
39	1-Oct	23				23	0	23
40	8-Oct	35				35	0	35
41	15-Oct	37	23			37	23	61
42	22-Oct	42	23			42	23	66
43	29-Oct	46	23			46	23	69
44	5-Nov	411	23			41	23	65
45	12-Nov	39	23			39	23	62
46	19-Nov	22	23			22	23	45
47	26-Nov	13	23			13	23	36
48	3-Dec	12	23			12	23	35
49	10-Dec	9	23			9	23	32
50	17-Dec	41	23			4	23	27
51	24-Dec	3	23			3	23	26
52	31 -Dec	0	23			0	23	23
	Maximum	46		136	240	240	136	240

SITE LAYOUTS

Imnaha fall chinook site layouts are depicted on the following figures.

PRELIMINARY COST ESTIMATES

Preliminary cost estimates (+50%, -30%) for the Imnaha fall chinook drainage basin are shown on Table 62.



IMNAHA DRAINAGE BASIN

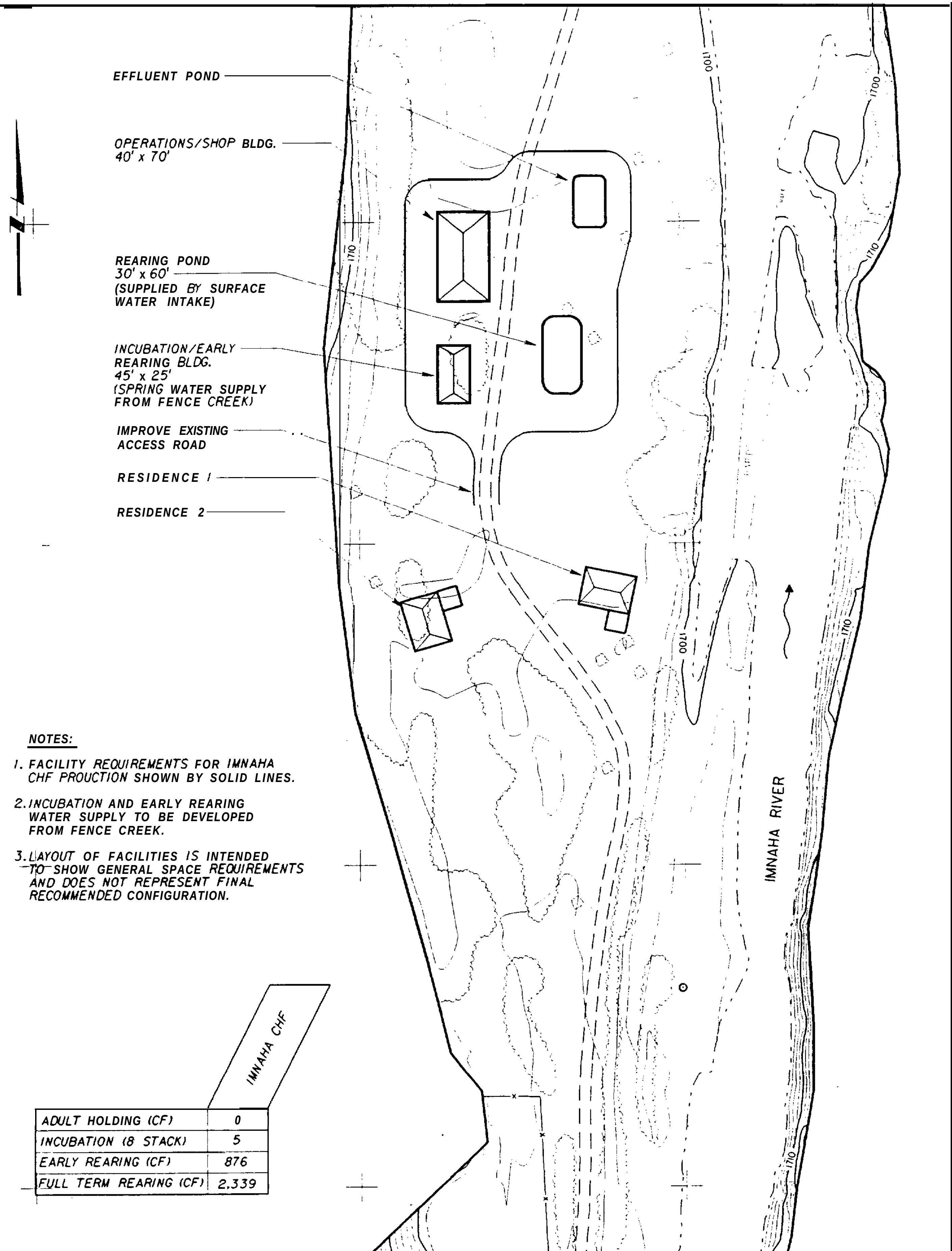
FALL CHINOOK PROGRAM
PREFERRED AND ALTERNATIVE SITES

FIGURE 27

TABLE 62

BONNEVILIE POWER ADMINISTRATION
GENE MARR RANCH HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
MOBILIZATION/DEMOBILIZATION	LS	1	$35,000	$35,000	$35,000
SITEWORK:					
Clearing and Grubbing	AC	1.50	$1,500	$2,250	
Landscaping	LS	1	$3,000	$3,000	
Gravel surfacing (all driving surfaces)	CY	400	$15	$6,000	
Earthwork	LS	1	$15,000	$15,000	
Erosion Control (rip-rap)	CY	100	$60	$6,000	
Fencing	LF	800	$18	$14,400	
Gates	EA	2	$600	$1,200	$47,850
HATCHERY BUILDING					
bldg is one floor incl. everything w/ii walls except:	SF	1,125	$55	$61,875	
Incubators. 8 stack	EA	5	$950	$4,750	
Rearing troughs, 500 gal ea.	EA	14	$1,600	$22,400	$89,025
HEADTANK					
Conc. and misc. metals	CY	25	$475	$11,875	
piping, valves, weir, railing, and misc.	LS	1	$15.000	$15,000	$26,875
REARING POND					
Earthwork	covered above under “sitework”				
subgrade	SY	80	$5	$400	
Asphaltic lining	SY	80	$10	$800	
Hydraulic structures	LS	2	$5,000	$10,000	$11,200
EFFLUENT POND					
Earthwork	covered above under “sitework”				
subgrade	SY	220	$5	$1,100	
Asphaltic lining	SY	220	$10	$2,200	
Hydraulic structures	LS	2	$7.500	$15,000	$18,300
YARD PIPING					
	LS	1	$150,000	$150,000	$150,000
OPERATIONS BUILDING building is one floor w/ feed room, garage, offices, lab. incl. everything w/in walls	SF	2,800	$68	$190,400	$190,400
RESIDENCES					
two 3 bdr houses, 1400 sf living area	SF	2,800	$62	$173,600	
two 400 sf garages	SF	800	$38	$30,400	$204,000
SURFACE WATER INTAKE PIPE	LF	1,500	$60	$90,000	$90,000
SPRING WATER INTAKE PIPELINE	LF	1,500	$20	$30,000	$30,000



NOTES:

1. FACILITY REQUIREMENTS FOR IMNAHA CHF PROUCTION SHOWN BY SOLID LINES.
2. INCUBATION AND EARLY REARING WATER SUPPLY TO BE DEVELOPED FROM FENCE CREEK.
3. LAYOUT OF FACILITIES IS INTENDED TO SHOW GENERAL SPACE REQUIREMENTS AND DOES NOT REPRESENT FINAL RECOMMENDED CONFIGURATION.

	IMNAHA CHF
ADULT HOLDING (CF)	0
INCUBATION (8 STACK)	5
EARLY REARING (CF)	876
FULL TERM REARING (CF)	2,339

SCALE: 1"=100'

MONTGOMERY WATSON
Bellevue, Washington

BONNEVILLE POWER ADMINISTRATION
NORTHEAST OREGON HATCHERY PROJECT
GENE MARR RANCH - IMNAHA RIVER
FALL CHINOOK HATCHERY

FIGURE: 28

TABLE 62

BONNEVILLE POWER ADMINISTRATION
GENE MARR RANCH HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

Category	Units	Quantity	$/Unit	Total	Category Total
RIVER INTAKE STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	45	$475	$21,375	
Misc. metals	LS	1	$4,500	$4,500	
Wedgewire screen	SF	250	$90	$22,500	
Sluice gate	EA	1	$3,000	$3,000	
Automatic screen cleaner	EA	1	$70,000	$70,000	
Baffles	LS	1	$5,000	$5,000	
Stoplogs	LS	1	$9,000	$9,000	
Pipe specials	LS	1	$3,000	$3,000	
Dewatering	LS	1	$12,000	$12,000	$150,375
RIVER EFFLUENT STRUCTURE					
Earthwork and erosion protection	covered above under "sitework"				
Concrete	CY	30	$475	$14,250	
Misc. metals	LS	1	$2,000	$2,000	
Dewatering	LS	1	$5,000	$5,000	$2 1,250
SPRING INTAKE STRUCTURE	LS	1	$10,000	$10,000	$10,000
POTABLE WELL WATER SYSTEM	LS	1	$8,000	$8,000	$8,000
UTILITY WATER PUMP STATION	LS	1	$6.000	$6,000	$6,000
ELECTRICAL (7% of subtotal)	LS	1	$69,100	$82,350	$82,350
INSTRUMENTATION (0.5% of subtotal)	LS	1	$4,900	$5,900	$5,900
				SUBTOTAL	$1,176,525
				ESTIMATING CONTINGENCY (25%)	$294,131
				CONTRACTORS OH & PROFIT (20%)	$235,305
				TOTAL CONSTRUCTION COST (12/94)	$1,705,961

SITE LAYOUTS FOR WALLA WALLA

STEELHEAD PROGRAM

INTRODUCTION

This section presents the site layouts of the facilities required for the Walla Walla Steelhead Program. These facilities and the preferred / alternative sites were listed in Table 20. Preferred sites for all adult capture, holding, and final rearing are located within the Walla Walla basin (Figure **29).**

Incubation, early rearing, and full term rearing is proposed to be conducted at the Umatilla hatchery. In exchange, an equivalent amount of Umatilla Hatchery ChS production would be transferred to the Russell Walker ranch hatchery.

An existing ladder at the NE 8th Street bridge over the Walla Walla River in Milton Freewater will be redeveloped and serve as the adult capture site.

MAXIMUM FACILITY REQUIREMENTS

Table 63 lists the maximum facility requirements for water supply (gpm) and volume (cf) required for the Walla Walla steelhead program. The proposed layout to meet these requirements is also listed. The following drawings present a proposed site layout, emphasizing the ability of the preferred site to meet the space requirements. The final layout of the facilities at a site may differ from that shown in these drawings.

TABLE 63

MAXIMUM FACILITY REQUIREMENTS

WALLA WALLA STEELHEAD

Facility	Site	Water Supply (gpm)	Volume (cuft)	Proposed Layout
Incubation	Umatilla Hatchery	17	117,64 eggs	3 stacks of 8 trays/stack
Early Rearing	Umatilla Hatchery	160	222	4 fry troughs each 2O’x2.5’x1.25’ deep
Adult Holding/ Spawning	Russell Walker Ranch	119	200	Adult Raceway
Full Term Rearing	Umatilla Hatchery	2,562	15,921	7 raceways each lO’xlOO’x2.5’ deep
Final Rearing	Russell Walker Ranch	1,594	21,429	ponds or side channel

PRODUCTION TIMING AND TEMPERATURE CONSIDERATIONS

The current plan for production of Walla Walla steelhead is to hold the adults at the Russell Walker ranch. Incubation and rearing would occur at the Umatilla Hatchery. The natural water temperature of the South Fork Walla Walla River is actually too cold to meet the rearing schedule planned for StSu in this basin, however adult holding temperatures are fine.

The temperature data for the Walla Walla steelhead program is based on the temperature from the Harris Park USGS station. Temperature criteria consideration for the site based on the use of surface water for all phases is presented in Table 64 for comparison of sites. It is estimated that 1000 gpm of 45-60 °F groundwater could be developed at this site.

Based on the production goals and growth rates presented in Table 5 four growth models were simulated:

TABLE 64

COMPARISON OF ACTUAL TEMPERATURES, TEMPERATURE CRITERIA, AND DEGREE OF REQUIRED HEATING OR COOLING

Summer Steelhead - South Fork Walla Walla River

Water Source	Actual Release Date @ 5/lb	Actual Release Date @ 10/lb	Desired Release Date	Comments
GW for Incubation and Early Rearing SW for Rearing	August 4	May 7	March - May 15	Desired production timing out of phase
SW for Incubation: Early Rearing, . and Rearing	September 1	June 16	March - May 15	Desired production timing out of phase

GW = groundwater
SW = surface water or groundwater adjusted to the local surface water temperature

It does not appear possible to produce a 1 year steelhead smolts at this site. Discussion is currently underway to see if steelhead incubation and early rearing could be transferred to the Umatilla Hatchery and additional Spring Chinook production transferred to the Walla Walla site. Under this arrangement, the sub-smolts would be transported back to the Walla Walla site for final rearing.

Relative heating and cooling requirements are shown on Table 65.

TABLE 65

COMPARISON OF ACTUAL TEMPERATURES, TEMPERATURE CRITERIA, AND DEGREE OF REQUIRED HEATING OR COOLING

Temperature Criteria - Summer Steelhead - S. Fork Walla Walla River

	Actual Temperature (F)			Temperature Criteria (F)				Required ΔT (F)		
Month	10 % of Daily Min.	50% of Daily Average	75 % of Daily Max.	Max Adult Holding	Min Incub & Early Rearing	Max Incub& Early Rearing	Max Rearing	Adult Holding	Incub & Early Rearing	Rearing
Oct	42.1	44.6	46.0							
Nov	37.9	40.7	42.1	60						
Dec	37.0	39.5	41	60						
Jan	36.0	38.5	39.9	60						
Feb	37.0	39.6	41	60						
Mar	37.9	40.3	43.0	60	38	60			+0.1	
Apr	39.0	42.1	44.5	60	38	60				
May	41	44.8	48.9	60	38	60				
Jun	46.0	51.8	57.9			65	70			
Jul	48.0	54.3	61.0				70			
Aug	46.9	52.5	59				70			
Sep	45.0	48.8	52.0				70			
Oct	42.1	44.6	46.0				70			
Nov	37.9	40.7	42.1				70			
Dec	37.0	39.5	41				70			
Jan	36.0	38.5	39.9				70			
Feb	37.0	39.6	41				70			
Mar	37.9	40.3	43.0				70			
Apr	39.0	42.1	44.5				70			
May	41	44.8	48.9							
Jun	46.0	51.8	57.9							
Jul	48.0	54.3	61.0							
Aug	46.9	52.5	59							
Sep	45.0	48.8	52.0							
Oct	42.1	44.6	46.0							
Nov	37.9	40.7	42.1							
Dec	37.0	39.5	41							
Jan	36.0	38.5	39.9							
Feb	37.0	39.6	41							
Mar	37.9	40.3	43.0							
Apr	39.0	42.1	44.5							
May	41	44.8	48.9							
Jun	46.0	51.8	57.9							
Jul	48.0	54.3	61.0							
Aug	46.9	52.5	59							
Sep	45.0	48.8	52.0							

TABLE 66

REQUIRED FLOWS
RUSSEL WALKER RANCH

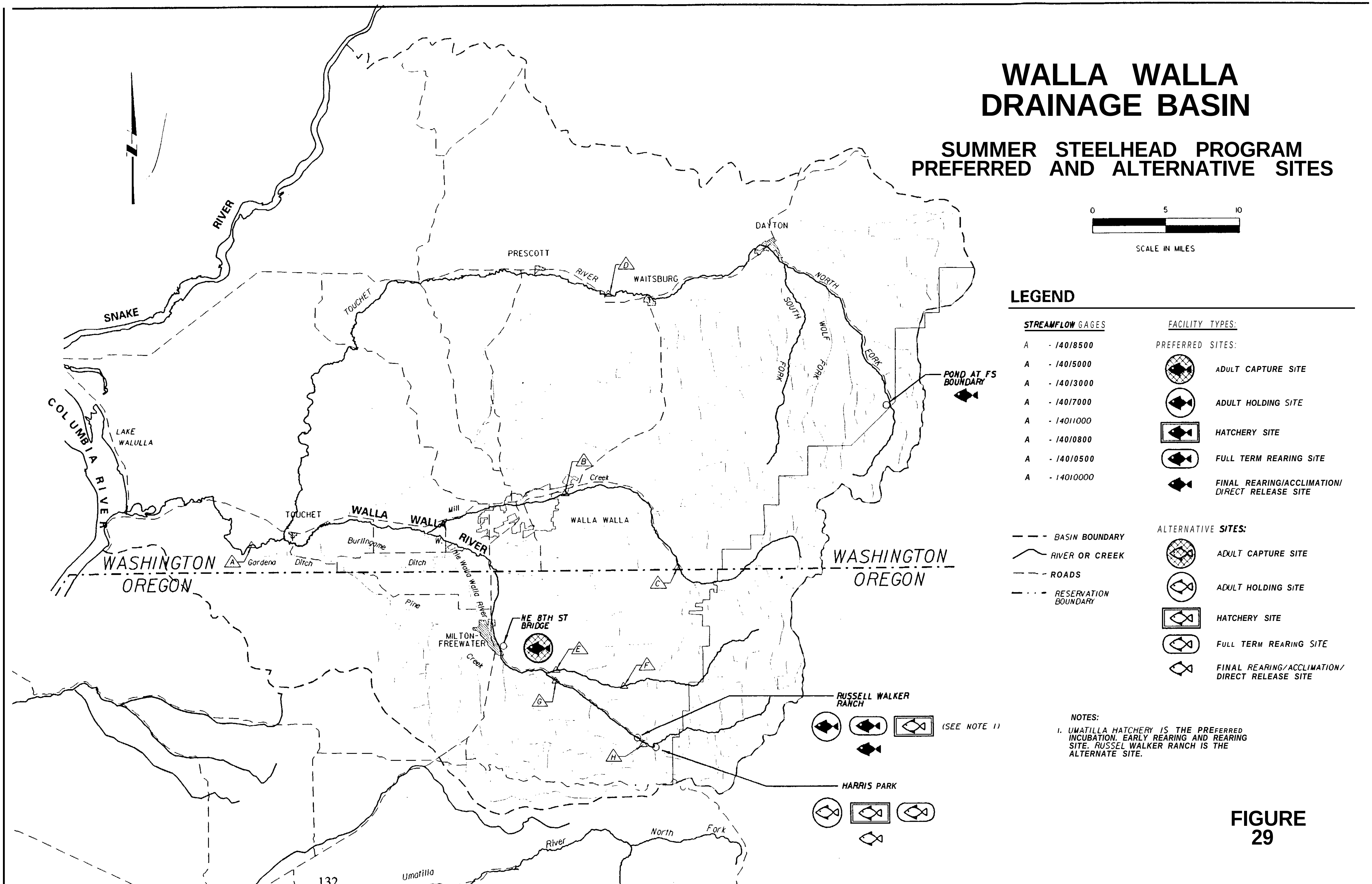
Week	Date	Adult Holding Surface Water Flow (gpm)	Incubation Groundwater Flow (gpm)	Early Rearing Groundwater Flow (gpm)	Rearing Surface Water Flow (gpm)	Rearing Surface Water Flow (gpm)	Total Surface Flow (gpm)	Total GW Flow (gpm)	Total Water Flow (gpm)
0	1-Jan								
1	8-Jan	50			348		398	0	398
2	15-Jan	58			374		432	0	432
3	22-Jan	68			370		437	0	437
4	29-Jan	80			380		460	0	460
5	5-Feb	97			422		519	0	519
6	12-Feb	110			438		548	0	548
7	19-Feb	119			431		550	0	550
8	26-Feb	118			434		552	0	552
9	5-Mar	109			400		509	0	509
10	12-Mar	110			457		566	0	566
11	19-Mar	104			486		590	0	590
12	26-Mar	97			514		611	0	611
13	2-Apr	83			499		582	0	582
14	9-Apr	76			537		614	0	614
15	16-Apr	65			550		615	0	615
16	23-Apr	55			562		617	0	617
17	30-Apr	48			616		664	0	664
18	7-May	37			624		661	0	661
19	14-May	27			672		700	0	700
20	21-May	17			698		715	0	715
21	28-May	6			750		755	0	755
22	4-Jun	0			843		843	0	843
23	11-Jun	0			925		925	0	925
24	18-Jun	0			1039		1039	0	1039
25	25-Jun	0			1115		1115	0	1115
26	2-Jul	0			1149		1149	0	1149
27	9-Jul	0			1210		1210	0	1210
28	16-Jul	0			1305		1305	0	1305
29	23-Jul	0			1386		1386	0	1386
30	30-Jul	0			1402		1402	0	1402
31	6-Aug	0			1439	173	1612	0	1612
32	13-Aug	0			1492	193	1685	0	1685
33	20-Aug	0			1533	212	1745	0	1745
34	27-Aug	0			1569	232	1801	0	1801
35	3-Sep	0			1594	249	1843	0	1843
36	10-Sep	0				258	258	0	258
37	17-Sep	0				283	283	0	283
38	24-Sep	0				280	280	0	280
39	1-Oct	0				308	308	0	308
40	8-Oct	0				303	303	0	303
41	15-Oct	0				307	307	0	307
42	22-Oct	0				322	322	0	322
43	29-Oct	0				350	350	0	350
44	5-Nov	0				333	333	0	333
45	12-Nov	0				322	322	0	322
46	19-Nov	6				307	313	0	313
47	26-Nov	12				340	352	0	352
48	3-Dec	18				336	353	0	353
49	10-Dec	23				332	356	0	356
50	17-Dec	30				357	387	0	387
51	24-Dec	36				373	409	0	409
52	31-Dec	40				355	395	0	395
	Maximum	119	0	0	1594	373	1843	0	1843

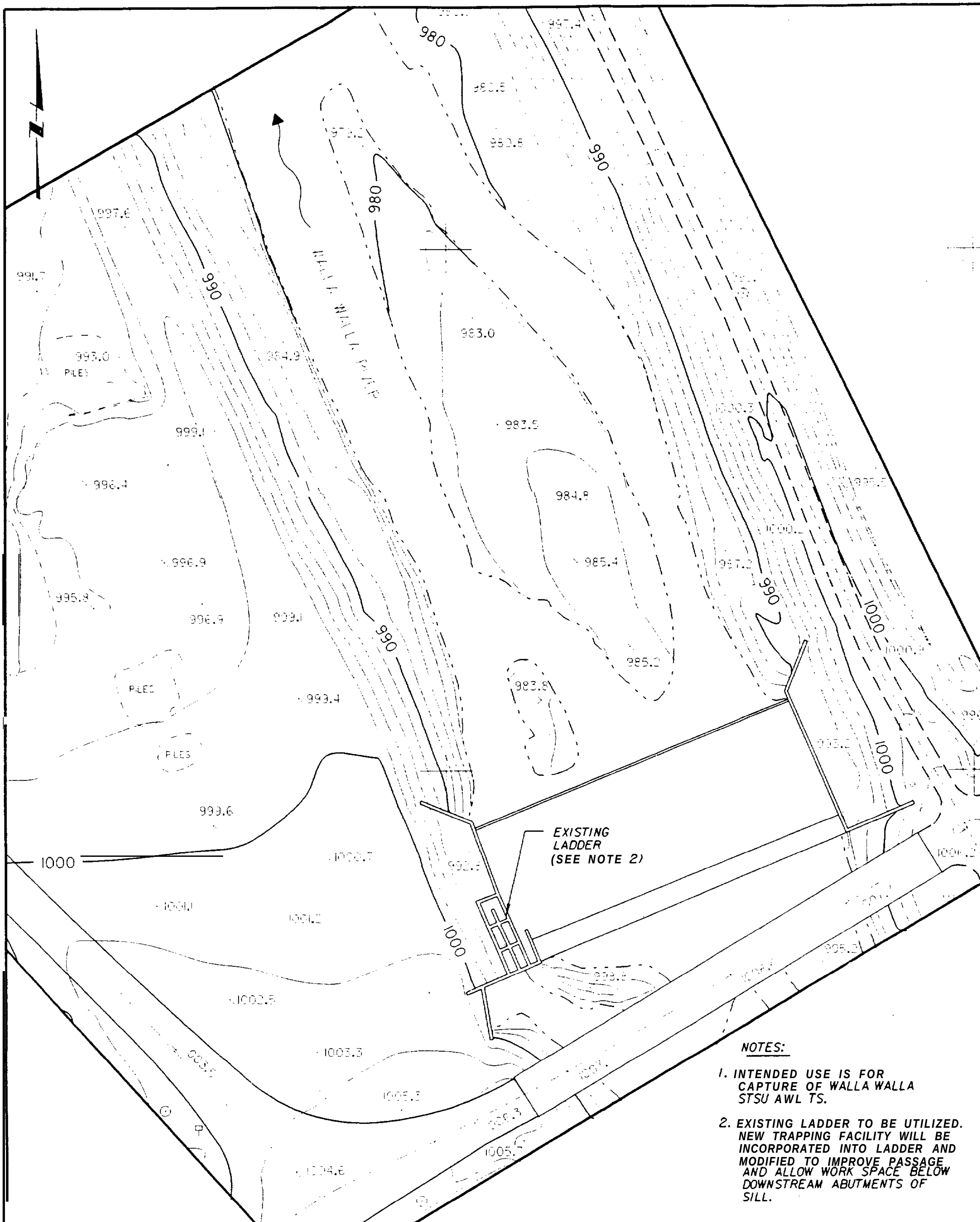
SITE LAYOUTS

Adult holding will occur at the Russell Walker Ranch, these facilities are illustrated on Figure 18 for Walla Walla - Touchet spring chinook. All incubation and rearing will occur at the existing Umatilla Hatchery. The following layout is for adult capture at the NE 8th Street Bridge steelhead ladder.

PRELIMINARY COST ESTIMATES

Preliminary cost estimates for Walla Walla Summer Steelhead basin (+50%, -30%) are shown on Table 67.


WALLA WALLA
DRAINAGE BASIN
SUMMER STEELHEAD PROGRAM
PREFERRED AND ALTERNATIVE SITES
0 5 10
SCALE IN MILES
LEGEND
STREAMFLOW GAGES
A - 14018500
A - 14015000
A - 14013000
A - 14017000
A - 14011000
A - 14010800
A - 14010500
A - 14010000
FACILITY TYPES:
PREFERRED SITES:
ADULT CAPTURE SITE
ADULT HOLDING SITE
HATCHERY SITE
FULL TERM REARING SITE
FINAL REARING/ACCLIMATION/ DIRECT RELEASE SITE
ALTERNATIVE SITES:
ADULT CAPTURE SITE
ADULT HOLDING SITE
HATCHERY SITE
FULL TERM REARING SITE
FINAL REARING/ACCLIMATION/ DIRECT RELEASE SITE
BASIN BOUNDARY
RIVER OR CREEK
ROADS
RESERVATION BOUNDARY
NOTES:
1. UMATILLA HATCHERY IS THE PREFERRED INCUBATION, EARLY REARING AND REARING SITE. RUSSEL WALKER RANCH IS THE ALTERNATE SITE.
POND AT FS BOUNDARY
NE 8TH ST BRIDGE
RUSSELL WALKER RANCH
(SEE NOTE 1)
HARRIS PARK
SNAKE
RIVER
COLUMBIA RIVER
LAKE WALULLA
PRESCOTT
DAYTON
WAITSBURG
TOUCHET
TOUCHET RIVER
NORTH FORK
SOUTH FORK
WOLF FORK
WALLA WALLA RIVER
Mill Creek
WALLA WALLA
Burlingame Ditch
Gardena Ditch
Little Walla Walla River
Pine
MILTON-FREEWATER
Creek
WASHINGTON
OREGON
Umatilla River
North Fork
FIGURE 29



NOTES:

1. INTENDED USE IS FOR CAPTURE OF WALLA WALLA STSU AWL TS.
2. EXISTING LADDER TO BE UTILIZED. NEW TRAPPING FACILITY WILL BE INCORPORATED INTO LADDER AND MODIFIED TO IMPROVE PASSAGE AND ALLOW WORK SPACE BELOW DOWNSTREAM ABUTMENTS OF SILL.

NOVEMBER 1994

SCALE: 1" = 60'	MONTGOMERY WATSON Bellevue, Washington	BONNEVILLE POWER ADMINISTRATION NORTHEAST OREGON HATCHERY PROJECT N.E. 8TH ST BRIDGE – WALLA WALLA RIVER ADULT CAPTURE SITE	FIGURE: 30

TABLE 67

BONNEVILLE POWER ADMINISTRATION
RUSSELL WALKER - SOUTH FORK WALLA WALLA HATCHERY
CONCEPTUAL LEVEL CONSTRUCTION COST ESTIMATE

ITEM	MERWIN	DESCRIPTION	SF WALLA WALLA	DESCRIPTION
	total flow=5000		total flow= 12000	
	disinfected flow==4000		disin. flow=> 2000	
ELEMENTS SIMILAR TO MERWIN:				
Mobilization	4% of total		500,000	use 5% for remoteness
demobilization	0.5% of total		75,000	use 0.75%
Instrumentation	60,000		60,000	same
Sitework	700,000		I,200,000	approx same area-bad soils
Hatchery/E.R. Bldg	1,000,000	111/sf	754,800	6800 sf
Operations Bldg	725,000	lOO/sf footprint	900,000	9000 sf
Effluent ponds	170,000		305,000	flow ratio^0.67
Yard piping	670,000		1,204,526	flow ratio^0.67
intake pumps/pipe	550,000		900,000	estimate
ozone contact	225,000		660,000	per Boise
ozone gen bldg	200,000		530,000	per Boise
ozone stripping	210,000		780,000	per Boise
aeration system	70,000		incl. wl raceways	
LOX storage	12,000		30,000	
Post ozone P.S.	100,000		incl. w/ intake P.S.	
Bonds and taxes	7.3% of total		690,000	same
ELEMENTS NOT IN MERWIN:				
Raceways		3 mile-$16/cf	1,040,000	65000 cf x 3 mile factor
residences (2)			180,000	estimate
Intake and dam			204,000	per Boise
TOTAL MERWIN	$6,700,000	TOTAL S.F. WALLA	$10,013,326	
(low bid - 3/6/92)				

CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

This section presents a discussion of our conclusions and recommendations for several aspects of the conceptual design of the NEOH project. These include:

- A discussion of the potential for a central incubation facility based on groundwater availability and well-field development potential.
- Recommendation to consider the combination of the Imnaha ChS production at the Lostine River production facility site should further temperature monitoring show results similar to the assumed surface water temperatures at this site.
- Recommendation to consider the combination of the Imnaha ChF production at the Minam-Wallowa production facility site during the initial stages of run rebuilding. Final rearing and release facilities would be concurrently constructed at Marr Ranch. Incubation and early rearing would be phased in as adults return and a trap is needed.
- Recommended continuation of temperature monitoring.

POTENTIAL FOR CENTRAL INCUBATION FACILITY

Analysis of the potential to develop a central incubation facility site to satisfy production requirements for two or more subbasins was identified as a work task in the contract. As currently envisioned, the centralized hatchery facility would be the location for adult holding, spawning, incubation, and early rearing. Full-term rearing could also occur at this site if water and space were adequate. Each subbasin could have satellite facilities for subsequent full term rearing and/or acclimation facilities. The obvious advantage of a centralized facility is a reduction in the number of hatchery facilities that would need to be designed, permitted, and constructed.

The analysis presented below deals only with potential solutions to water supply and space. The water supply for incubation and early rearing must be pathogen free. This requires either groundwater or disinfected surface water. The construction of centralized facility may cost less than 3-5 separate facilities. Disease transmission and isolation concerns may tend to increase the cost of this facility compared to facility of similar size but holding only one stock. Effluent disinfection may be needed for the adult holding facility as fish will be transferred into the facility from other basins. A centralized incubation facility may actually reduce the combined risks if better staffed and designed with more backups and options.

In a facility with multi-stocks, there is greater potential for transmission of disease between stocks. In the event of disaster, there is also greater risk to all stocks. It is hard to quantify the increased risks due to the use of a centralized incubation facility. This choice between a centralized facility and a more distributed will be influenced by relative costs, operational characteristics, and policy issues.

Groundwater Availability

A major issue to be evaluated for the location of a central incubation facility was the availability of groundwater in sufficient quantity to satisfy incubation and early rearing requirements. A groundwater study consisting of test well development and pump testing was initiated to evaluate the potential to develop hatchery water supplies at four sites within the Grande Ronde and Imnaha drainage basins. These sites were selected during the site evaluation process as having a very high potential for groundwater in the quantity necessary to support one or more subbasin's production goals. Test well sites included:

- the OSU site on Catherine Creek,
- the confluence of the Minam and Wallowa Rivers,
- the Strathearn Ranch on the Lostine River, and
- the Wayne Marks Ranch on the Imnaha River.

Drilling and pump testing was completed at three of the sites in September. Drilling at the Strathearn Ranch was not conducted due to the recent sale of that property and unwillingness on the part of the new owners to commit to participating in the planning effort. Efforts are currently underway to evaluate groundwater at an alternative site, the ODF&W Bighorn Sheep Range, approximately 1 mile upstream of the Stratheam Ranch.

Tables 68 and 69 summarize the groundwater requirements for incubation and early rearing for the NEOH subbasins and fish groups (excluding Walla Walla) and a potential production well yield based on the drilling results. Separate tables are provided from Spring and Fall Chinook as there is little overlap in incubation and early rearing for the two species.

The production well estimates are preliminary and are subject to change as the pump test data is further analyzed. Estimates for the Gene Marr Ranch on the Imnaha River are for development of Falls Creek springs as a water source, no well was drilled at that site. Groundwater potential at the Russell Walker Ranch on the South Fork Walla Walla was evaluated during the Umatilla Satellites and Release Sites project and was determined to have an adequate groundwater supply to support planned incubation of spring chinook.

TABLE 68

SUMMARY OF GROUNDWATER REQUIREMENTS AND WELL DEVELOPMENT POTENTIAL

SPRING CHINOOK

Site	Fish group (see Tables 13 through 20)	Incubation Requirement (gpm)	Early Rearing Requirement (gpm)	Wellfield Production Potential (gpm)
OSU	Upper Grande Ronde /Catherine Creek	99	378	400-800 gpm
Wayne Marks Ranch	Imnaha	154	499	500-1,000
Strathearn Ranch	Wallowa-Lostine	172	655	not drilled
Total Program	(Does not include Umatilla and Walla Walla components)	535	1,951	

TABLE 69

SUMMARY OF GROUNDWATER REQUIREMENTS AND WELL DEVELOPMENT POTENTIAL

FALL CHINOOK

Site	Fish group (see Tables 13 through 20)	Incubation Requirement (gpm)	Early Rearing Requirement (gpm)	Wellfield Production Potential (gpm)
Minam-Wallowa Confluence	Grande Ronde	300	1,817	1,500-2,000 (70F- will require chilling)
Gene Marr Ranch (a)	Imnaha	23	136	400-800
Total ProgTam		323	1,953	

(a) No well drilled here. Estimated yield is from Falls Creek springs at the site

OSU Site. At the OSU site the projected long-term yield from the 170-foot well is estimated to be approximately 200 gpm with a 60-foot pumping water level. Well field (3-4 wells) development of the shallow basalt aquifer could probably double the yield to 400 gpm. Water temperatures would probably average about 51 °F, Deep drilling would result in additional (but warmer) groundwater. Additional drilling and well development would be necessary to determine potential yield, but 400-800 gpm of mixed warm and cold groundwater is probably realistic.

This site could support ChS production for Upper Grande Ronde and Catherine Creek if all well development discussed above proves out. The combined incubation and early rearing requirements of approximately 810 gpm is close to the upper anticipated range of production well potential. This site does not appear to have enough groundwater to support other subbasin production.

Wayne Marks site. At the Wayne Marks Ranch on the Imnaha River the projected yield from an efficient well at this site is 300 gpm with a 150-foot pumping level. Well field development (3-4 at 1,000 foot spacing) in the area might result in 500 to 1,000 gpm total. Water temperature probably average about 54 °F.

The Wayne Marks Ranch site appears to have enough groundwater to support incubation and early rearing with maximum production from a well-field. As with the OSU site, there does not appear to be adequate groundwater available for any additional production.

Minam - Wallowa Confluence. This site is located on the west bank of the Wallowa River just downstream from the confluence of the Minam River. Estimated production from an efficient well at the Minam site is about 800 to 1000 gpm with a 250-foot pumping level. The projected long-term yield from a well field in the area (3-4 wells at 1,000 foot spacing) would probably be in the range of 1500 to 2500 gpm. Water temperature would average about 70 ° F.

This site appears to have enough groundwater to support incubation and early rearing needs for the Grande Ronde Fall Chinook at the currently planned production level

Strathearn Ranch / ODF&W Bighorn Sheep Range. Drilling information is needed to determine groundwater potential. Our recommendation is to pursue test well drilling at the ODF&W Bighorn Sheep Range.

Gene Marr Ranch. Falls Creek spring water quantity appears adequate for production needs of Imnaha Fall chinook.

Water Supply Constraints

These preliminary groundwater analyses suggest that no one hatchery site would satisfy all NEOH production requirements using groundwater alone. The lack of access to the Strathearn Ranch needs to be addressed by drilling at the ODF&W Bighorn Sheep Range since the Wallowa-Lostine ChS component has a relatively large water requirement for incubation and early rearing. Though it appears probable that this site has groundwater available for the Wallowa-Lostine ChS production, it is not thought to have as good a potential as did the Stratheam Ranch area. Thus finding sufficient groundwater at the ODF&W Bighorn Sheep Range site to incorporate production from other subbasins is probably not likely.

The Minam - Wallowa confluence site appears to have the potential for the greatest quantity of groundwater development. The development potential would satisfy the currently planned full production level for Grande Ronde Fall chinook incubation and early rearing. It is also possible to consider production of some other stocks here pending the phased buildup of fall chinook production over time. This site was identified as an alternative site for production of Wallowa - Lostine ChS (see Table 15). The main disadvantage of this site is the high temperature of the groundwater (approximately 70 F). This water would have to be chilled 15-20 F before it could be used for incubation and 5-10 F for early rearing. The chilling for a centralized incubation will be significant.

Disinfected surface water could also be used for incubation and early rearing. This option would increase the potential site to 3 (Minam-Wallowa, OSU, and Stratheam Ranch). This approach should be considered by the TWG as an option. One advantage of using treated surface water is the ability to more closely match river temperatures in the hatchery and thus more closely simulate natural river conditions. The use of surface water incubation and early rearing significantly improves the production timing for some of the basins.

Space Constraints

Space constraints are evaluated at the proposed hatchery sites in subsequent sections, a brief summary is presented here. Several of the sites do not have enough space within their borders to accommodate very much additional production. These include the Catherine Creek at Union site, and the Gene Marr Ranch site. Sites that do not have severe space constraints include the OSU site, the Minam - Wallowa confluence site, and the Wayne Marks Ranch site. The ODF&W Bighorn Sheep Range has not been evaluated yet due to its late entry into the concept design process.

Other Considerations

Other considerations in evaluating the feasibility of a central incubation facility include space constraints and use of treated surface water.

Space constraints are evaluated at the proposed hatchery sites in subsequent sections, a brief summary is presented here. Several of the sites do not have enough space within their borders to accommodate very much additional production. These include the Catherine Creek at Union site, and the Gene Marr Ranch site. Sites that do not have severe space constraints include the OSU site, the Minam - Wallowa confluence site, and the Wayne Marks Ranch site. The ODF&W Bighorn Sheep Range has not been evaluated yet due to its late entry into the concept design process.

Using treated surface water as a supplement to groundwater at these sites without space constraints would be one method to combine production facilities. This has not been evaluated yet but should be considered by the TWG as an option. One advantage of using treated surface water is the ability to more closely match river temperatures in the hatchery and thus more closely simulate natural river conditions. This may be important for timing purposes.

IMNAHA RIVER CHS PRODUCTION

Surface water temperatures at the Wayne Marks ranch on the Imnaha River are outside the bounds of desired criteria for spring chinook production during a large part of several life phases (see discussion in the section titled Site Layouts for Wallowa -Lostine Spring Chinook Program). As a result, to meet criteria and bioprogramming requirements, substantial heating and cooling of the water is required. While not unsolvable from an engineering standpoint, this would require a hatchery with relatively greater mechanical components and power consumption compared to other sites with "better" surface water conditions.

As a result, we are recommending that Alternative 1 (Table 16) for Imnaha ChS production at the Lostine River facility for incubation, early rearing, and some portion of full term rearing be retained along with the preferred option of in-basin production. There is ample space at the Lostine River site (either Stratheam Ranch or Bighorn Sheep Range) and water quality conditions are good.

Under the alternative scenario, smolts would be transported to a full-term rearing channel at the Wayne Marks ranch in late winter, possibly January, for several months of rearing within the basin. Final rearing and acclimation would occur at the planned sites on the upper Imnaha.

IMNAHA FALL CHINOOK PRODUCTION

Both hatchery sites under consideration for fall chinook production appear to have ample space and acceptable ground and surface water supplies for designated producticn levels. Both programs also rely on an initial capture of broodstock away from the site, with the provision for eventual development of a trap for on-site collection of broodstock once the runs are increasing and broodstock requirements can be met within the subbasin.

It may be feasible to consider the incubation and early rearing of the Imnaha stock at the Minam Wallowa hatchery site, at least during the initial years of reintroduction. Final rearing, acclimation, and release facilities would be constructed at the Mat-r Ranch at the outset with the incubation and early rearing components phased in over time as runs begin returning to the Imnaha River. The Grande Ronde ChF production goal is much larger than the Imnaha, full production would probably not be met until some time after initiation of the project, and thus there may be some excess rearing capacity at this site that could be used for Imnaha ChF.

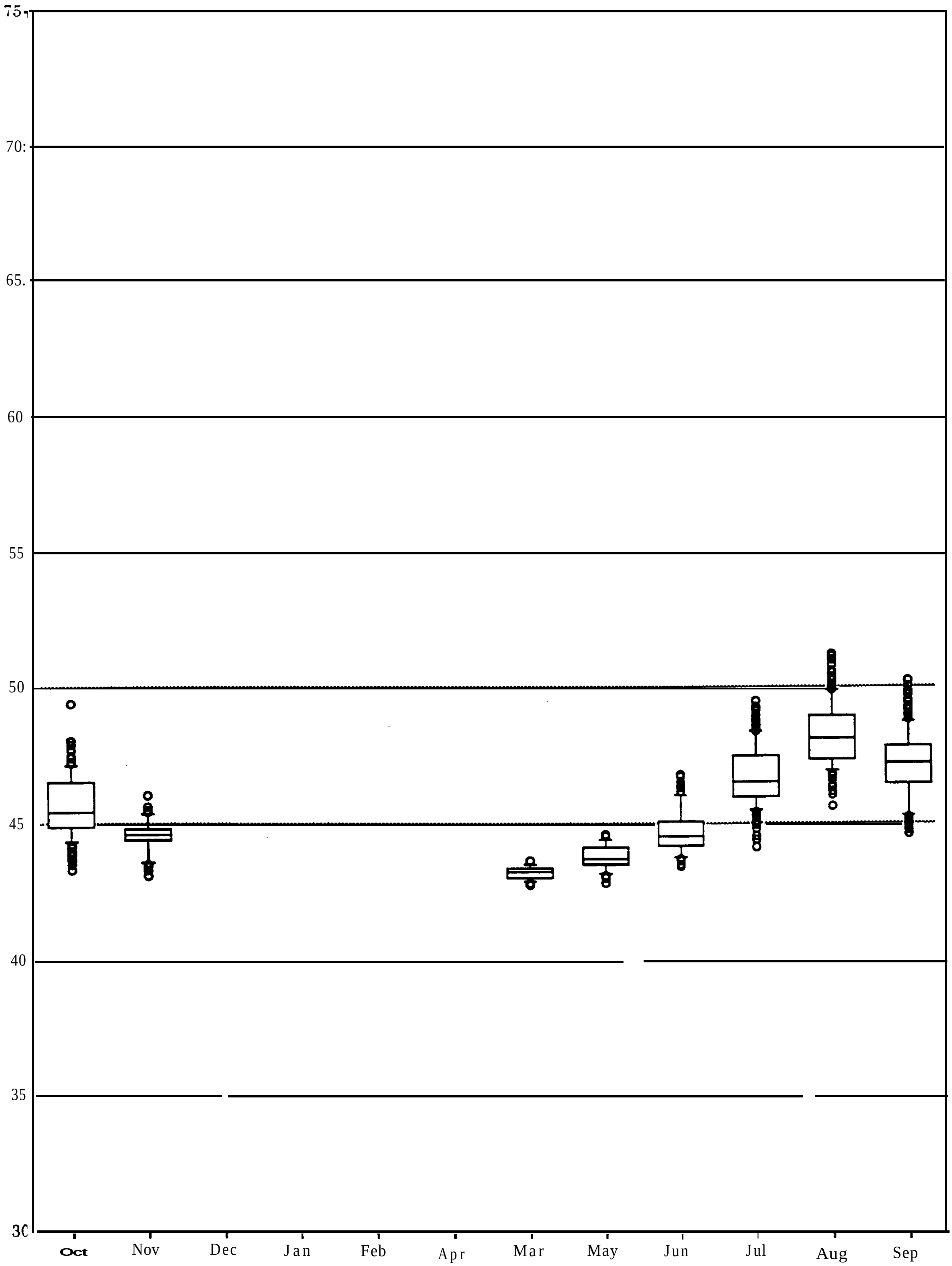
The Marr Ranch would be developed in phases with the timing of incubation and early rearing development dependent on rebuilding the run. Land could be acquired early on to reserve the site.

FUTURE TEMPERATURE MONITORING

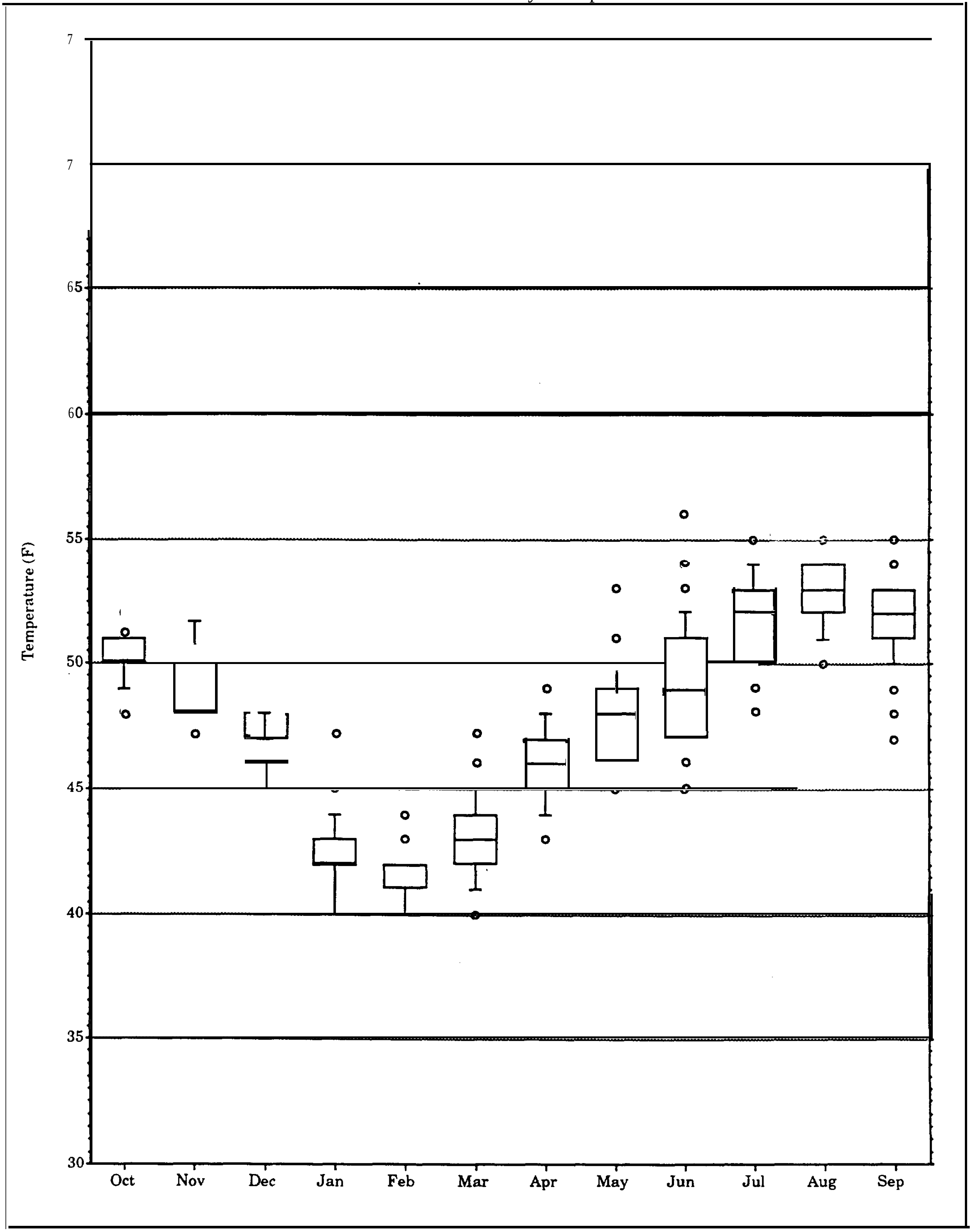
Long-term temperature data for a number of the sites within the project study area is lacking. We recommend that the current installation of Tempmentors at potential hatchery or acclimation sites within the study area be maintained. This information would be valuable during design of the facilities. Since design and construction may not occur for some time, there would be the opportunity to collect a few years' site specific data.

Appendix A Detailed Temperature Percentiles - Graphical Form

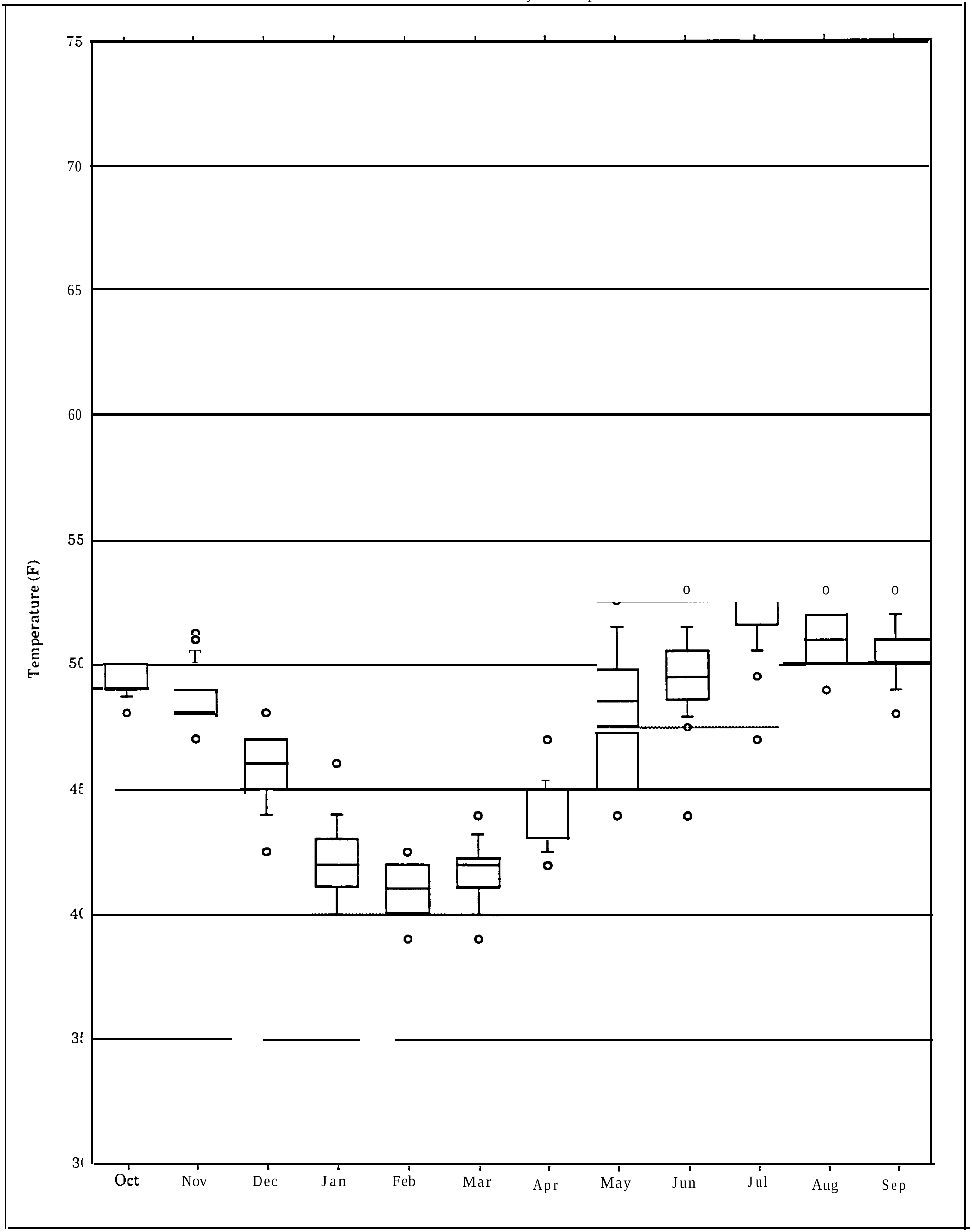
Carson - Average Daily Temperatures



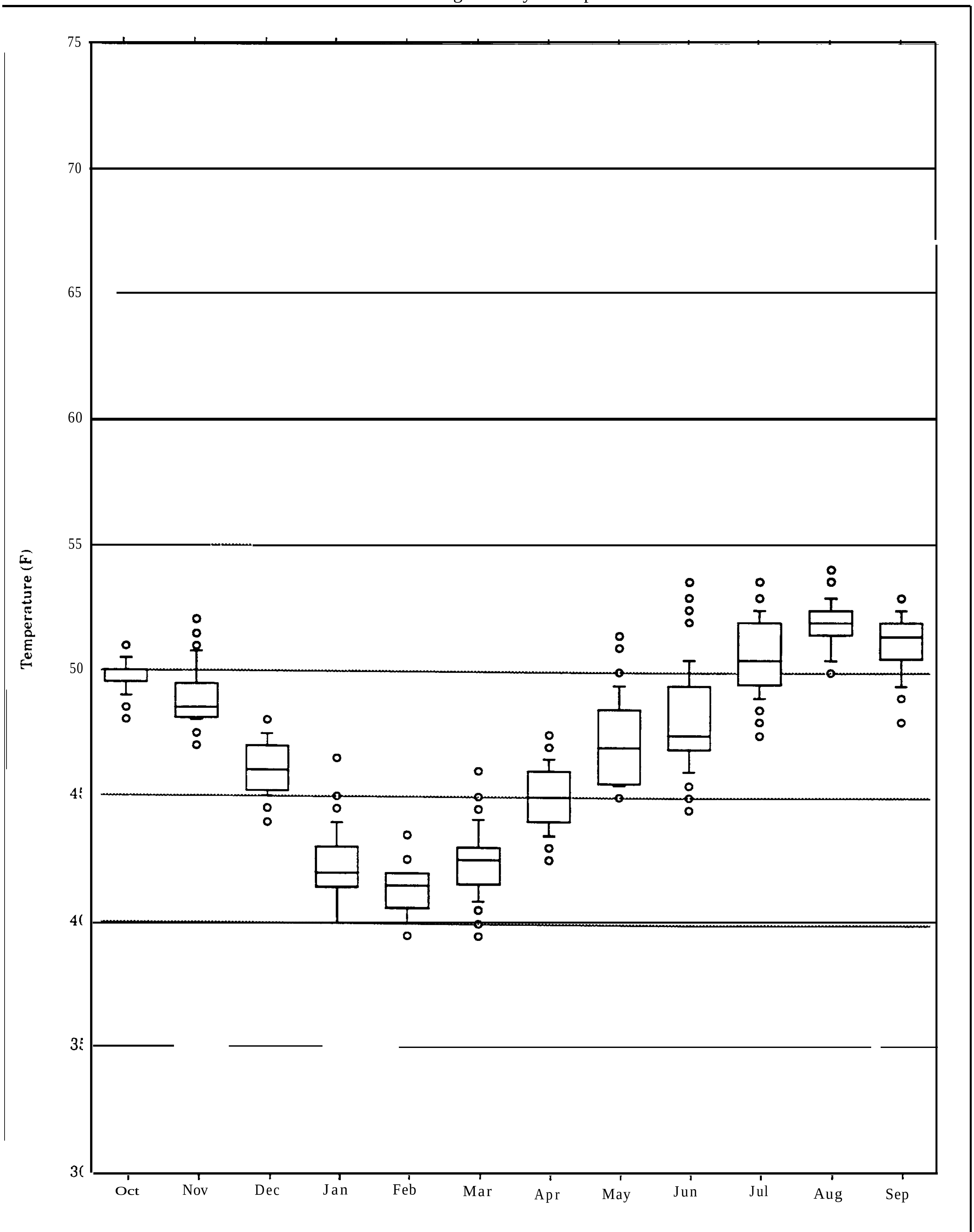
Cowlitz - Maximum Daily Temperature



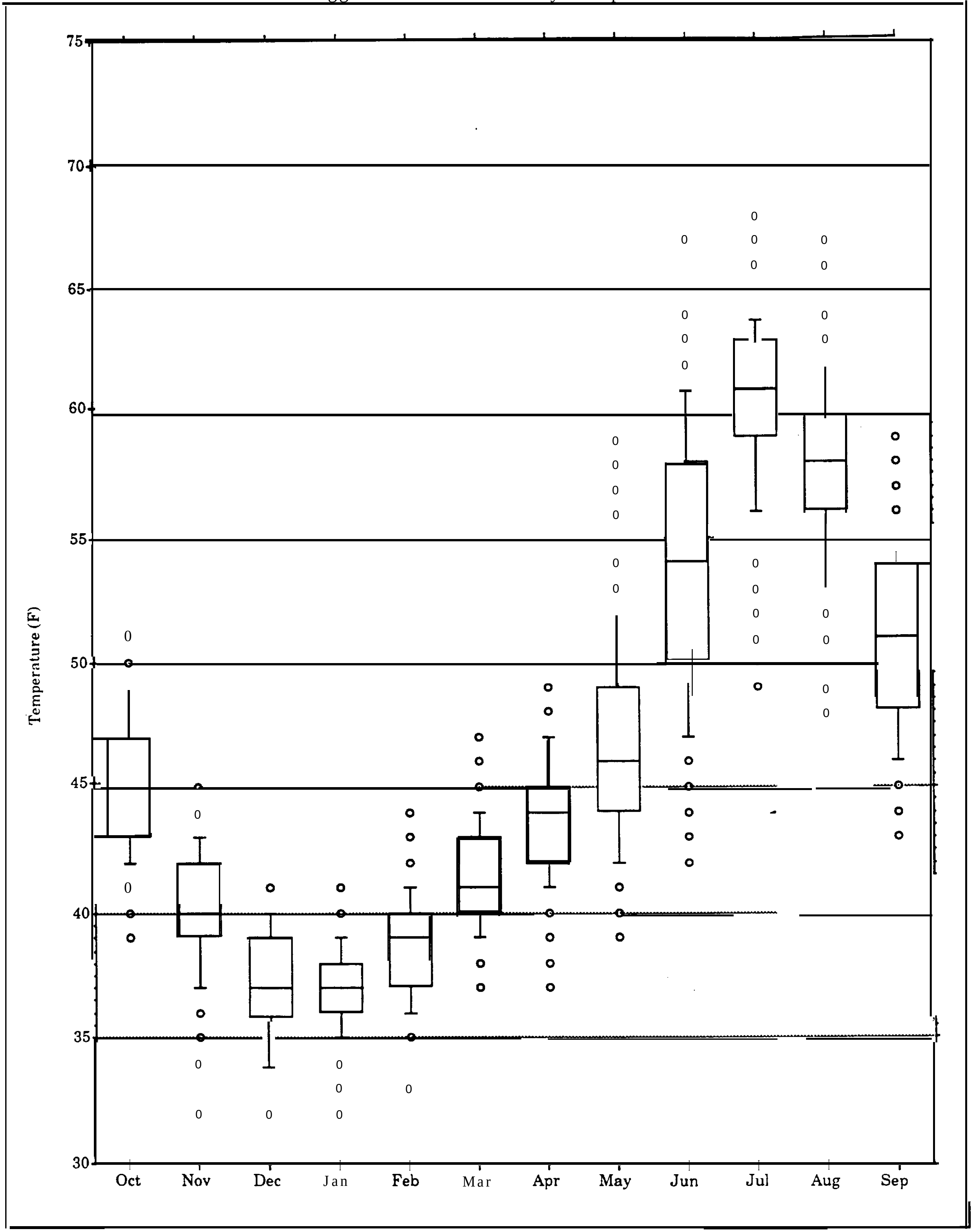
Cowlitz - Minimum Daily Temperature



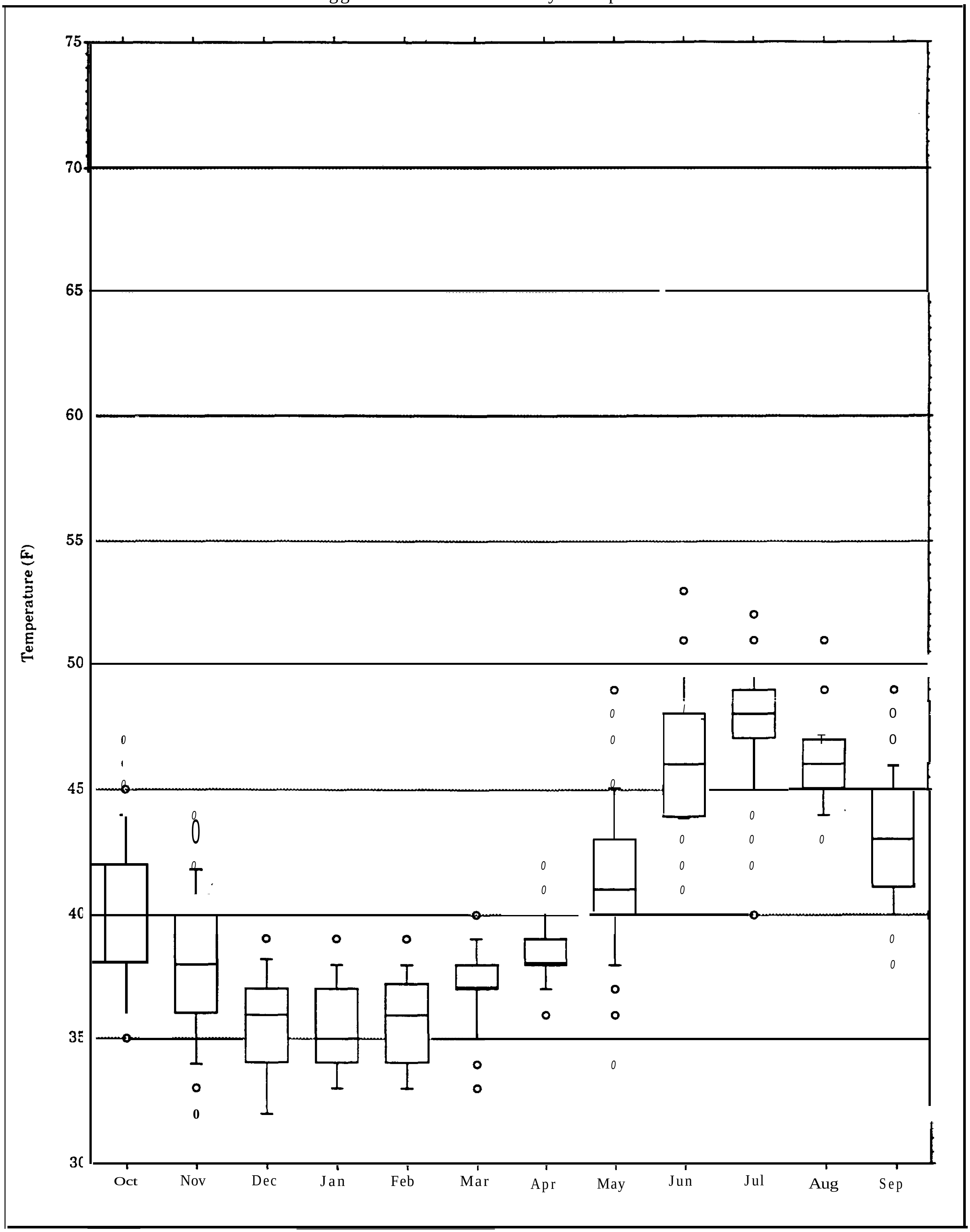
Cowlitz - Average Daily Temperature



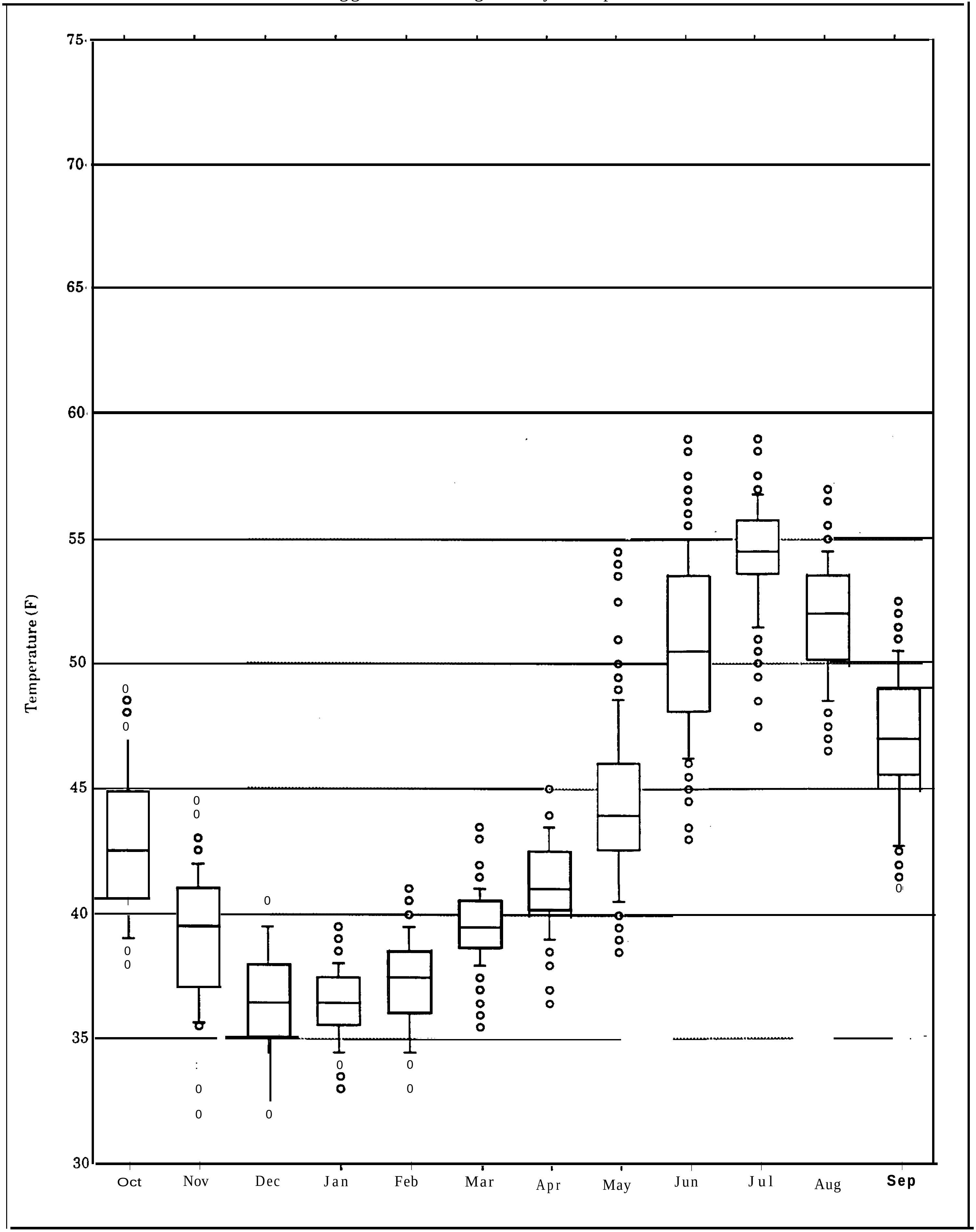
Lookingglass - Maximum Daily Temperatures



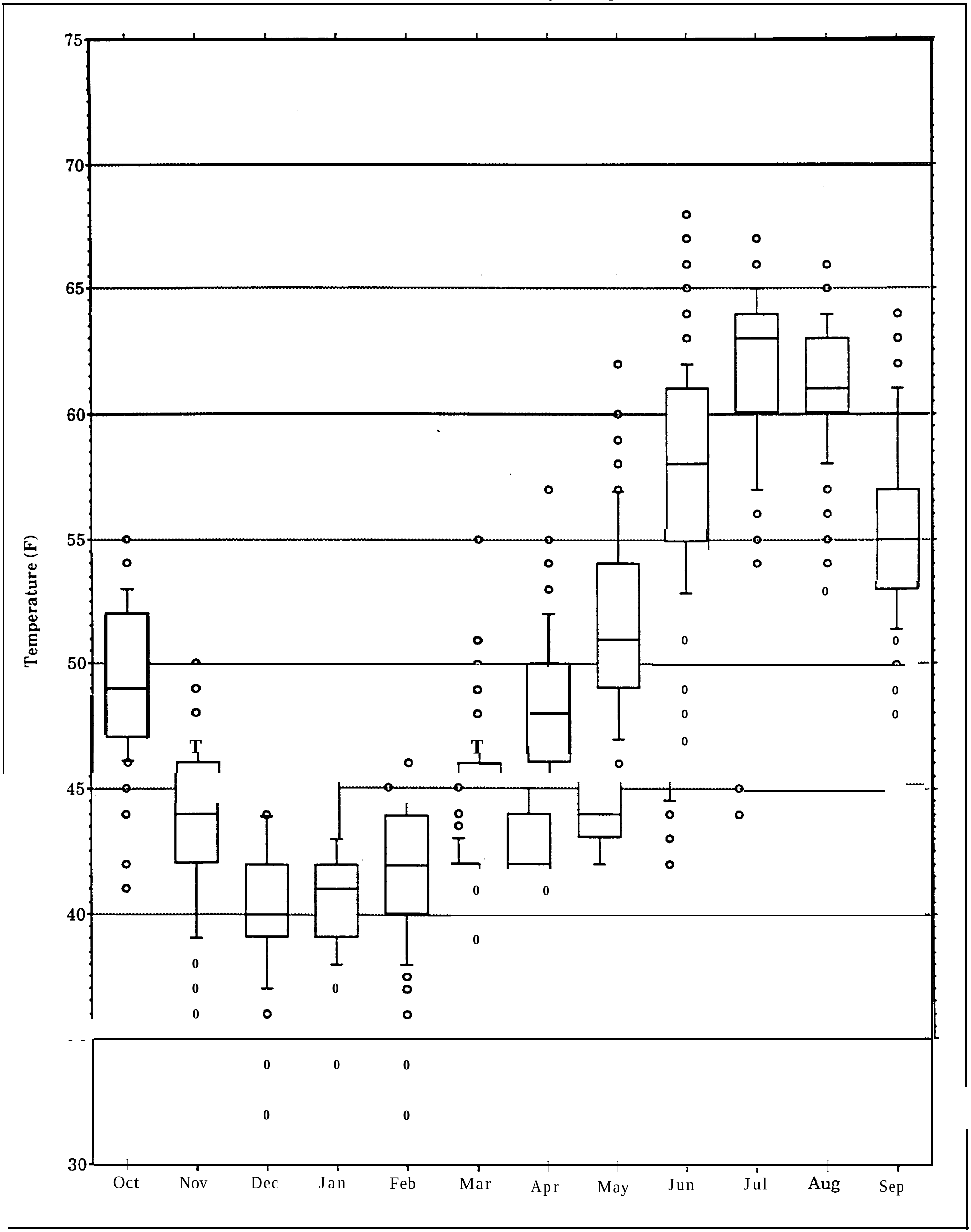
Lookingglass - Minimum Daily Temperatures



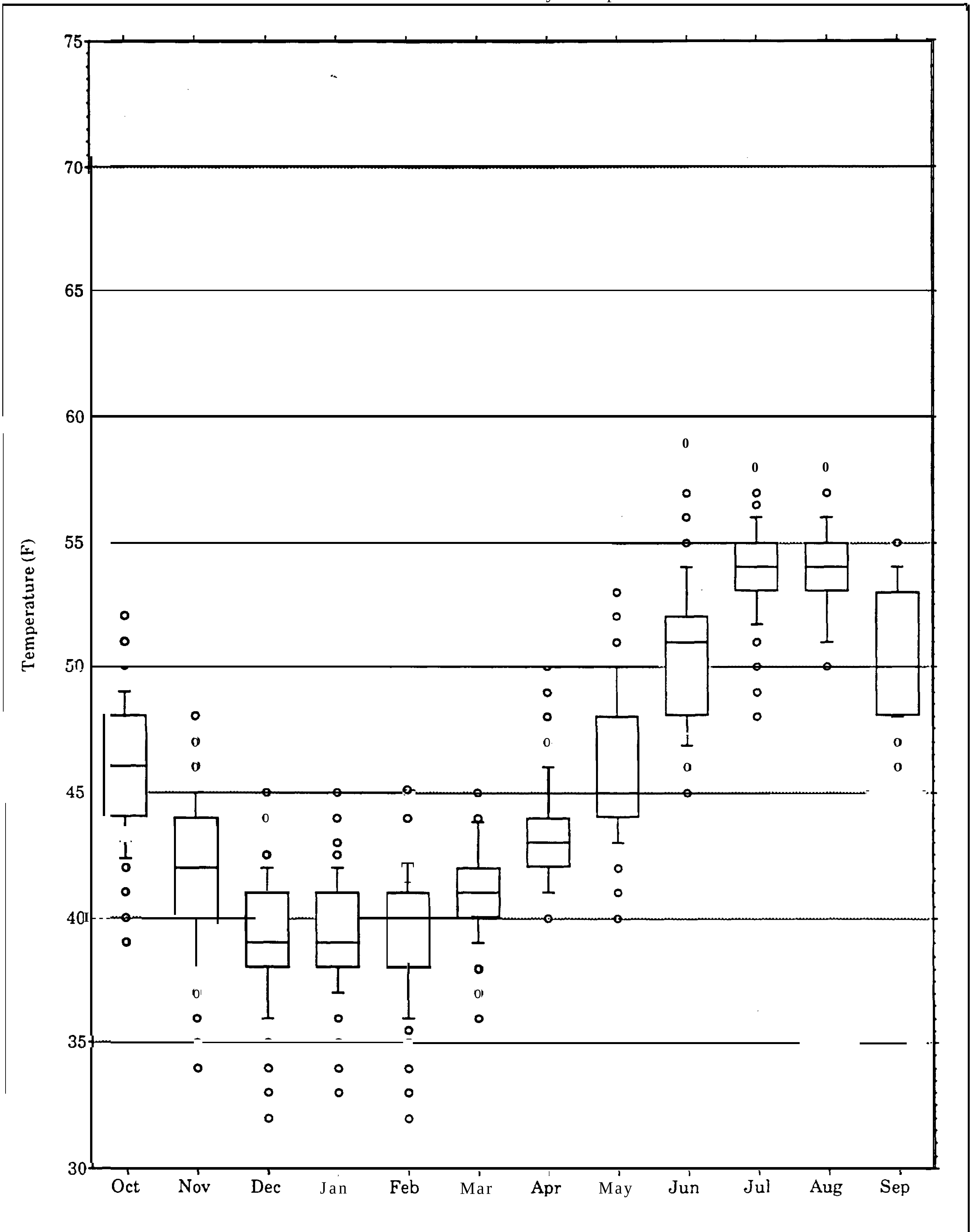
Lookingglass - Average Daily Temperatures



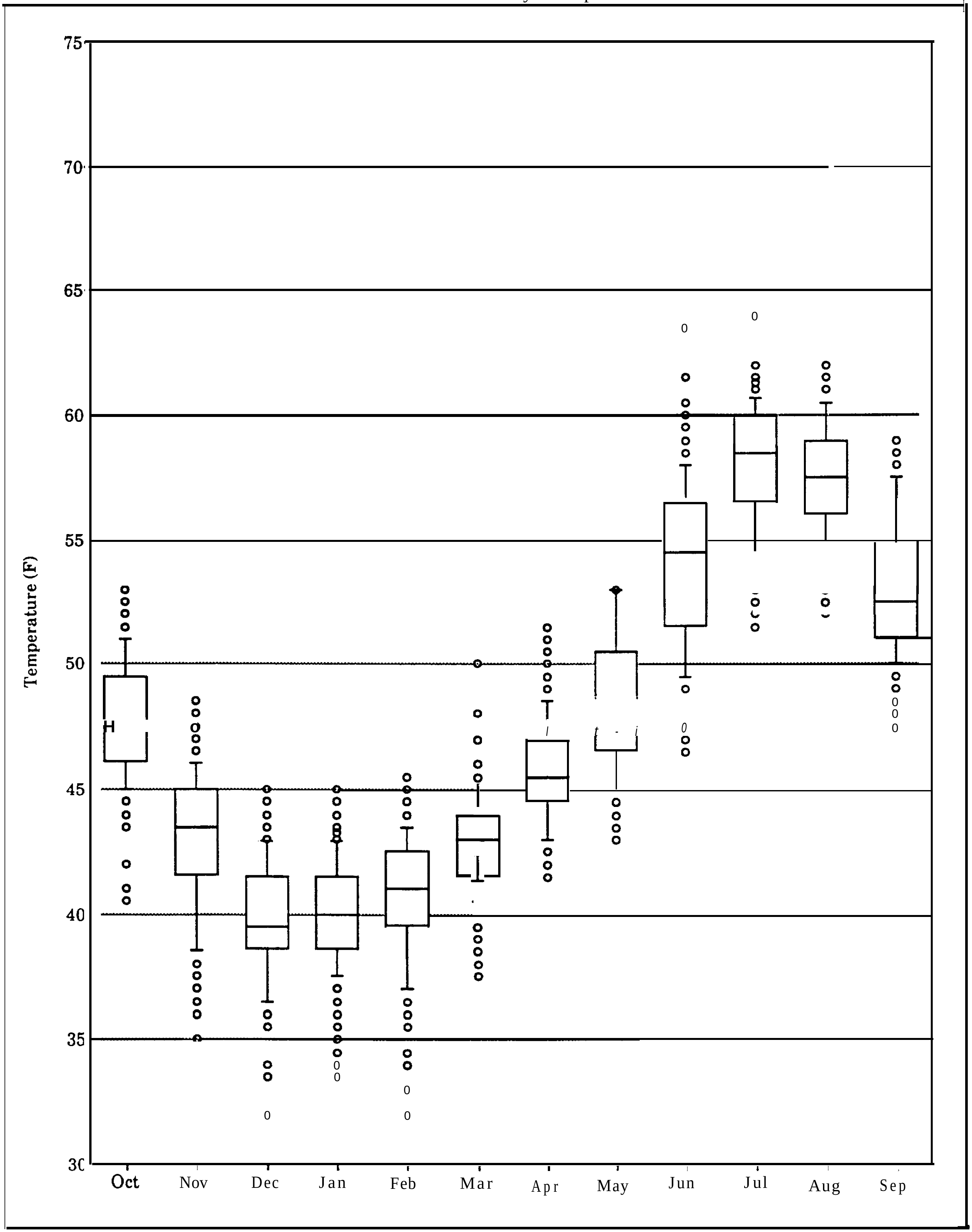
Willamette - Maximum Daily Temperature



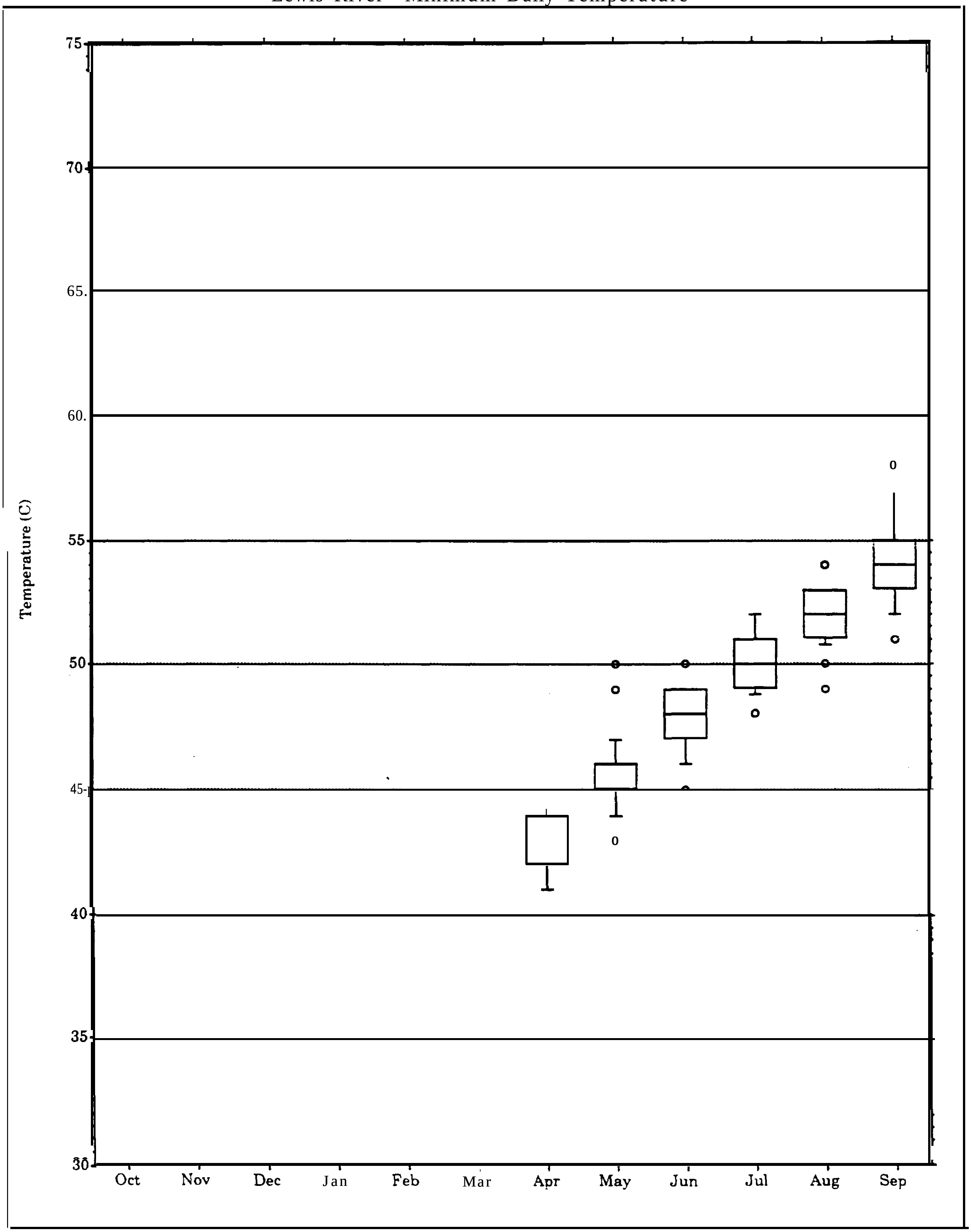
Willamette - Minimum Daily Temperature



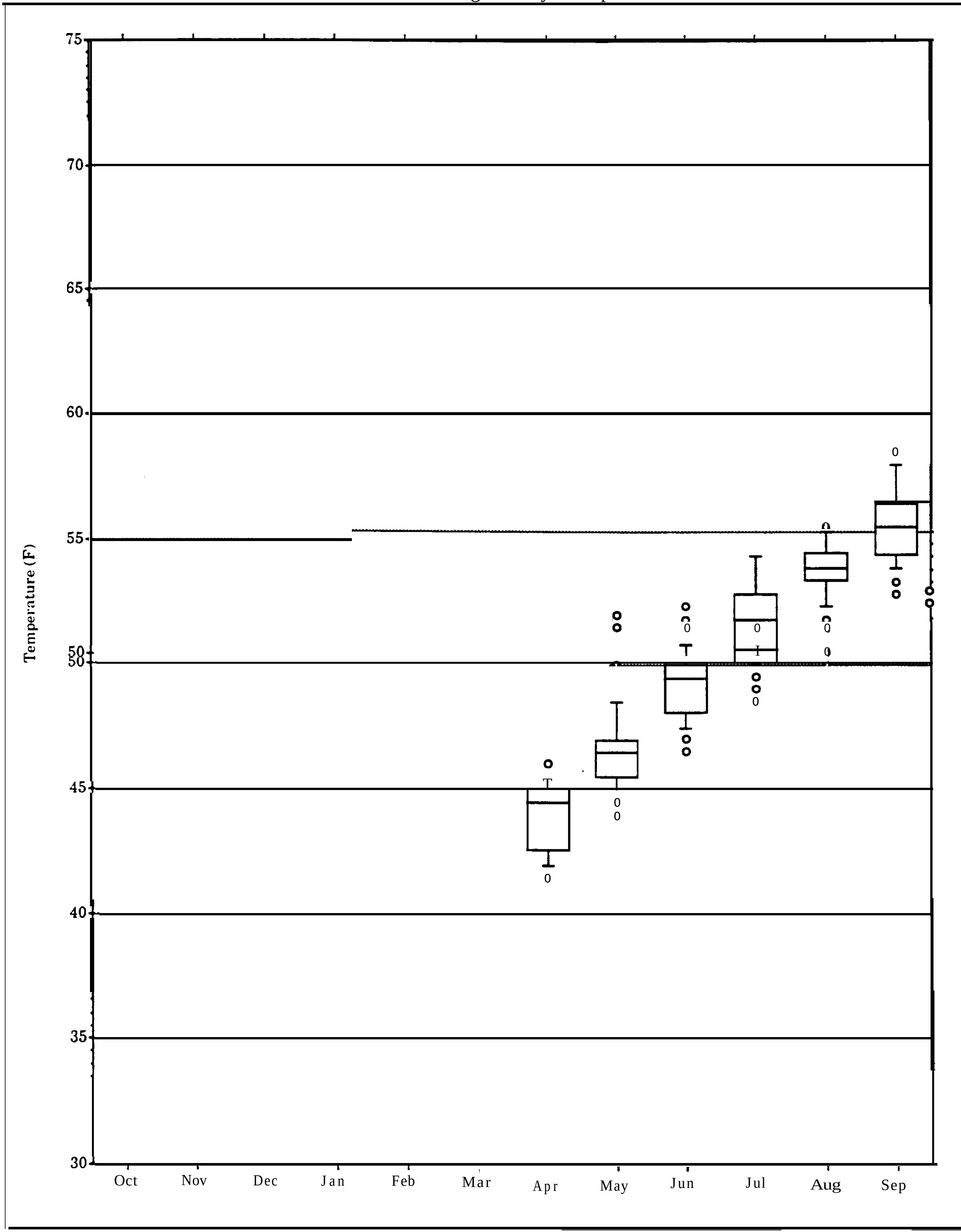
Willamette - Mean Daily Temperature

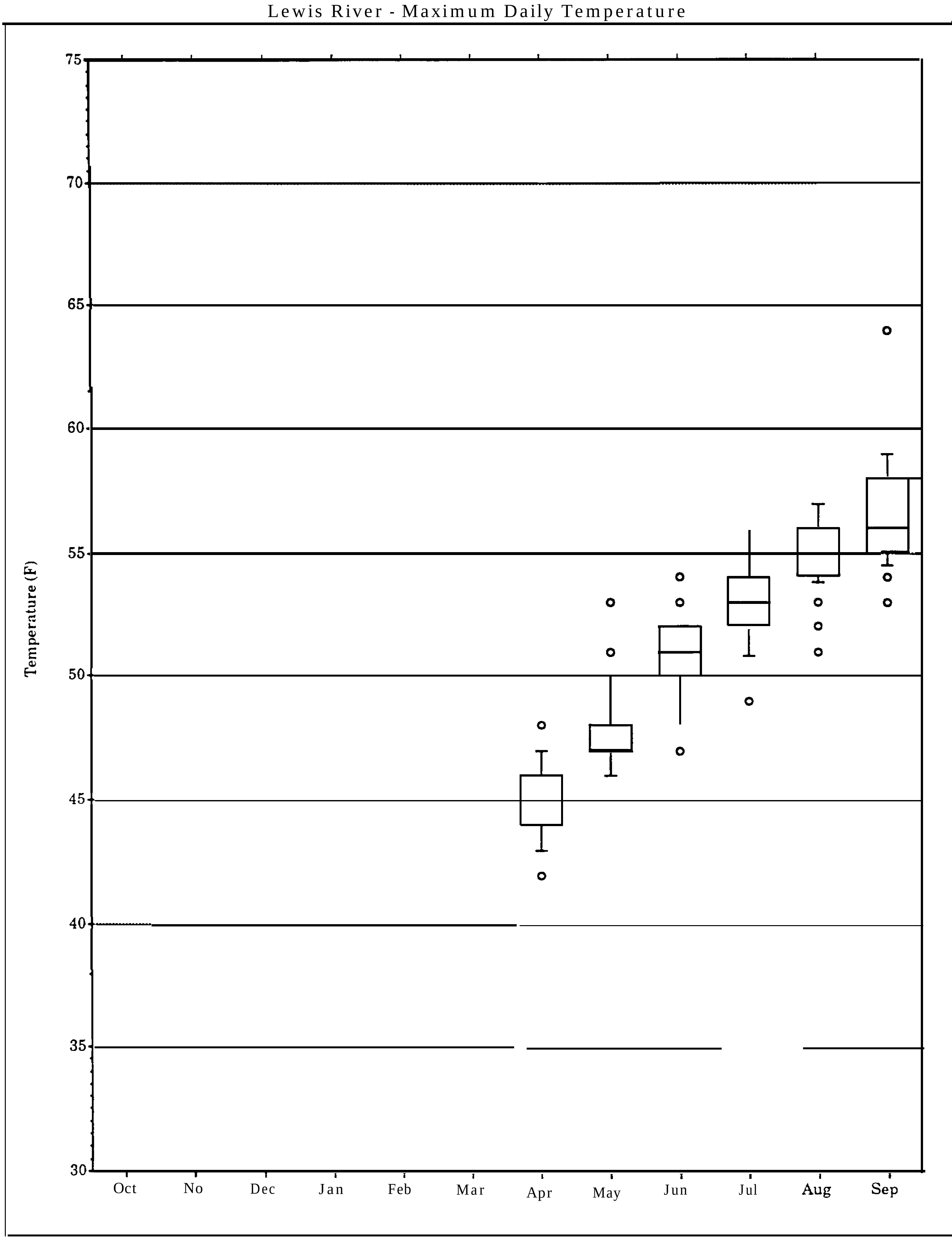


Lewis River - Minimum Daily Temperature



Lewis River - Average Daily Temperature





Lewis River - Maximum Daily Temperature
Temperature (F)
75
70
65
60
55
50
45
40
35
30
Oct
No
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep

APPENDIX B

TEMPERATURE DATA AND DATA NEEDS FOR THE NEOH PROJECT

The development and growth of fish strongly depends on water temperature. Extreme high and low temperatures may result in mortality of adults, eggs, and frv. At a hatchery, extreme cold temperatures can result in blockage of intakes and interrupt normal operations.

Surface water temperatures in the NEOH project area have been significantly modified by land use practices. To be able to successfully hold and rear salmon in these basins today may require significant heating and cooling of surface waters. Groundwater mixing may also be needed to adjust development timing and keep intakes functioning.

Available temperature data for the potential NEOH hatchery sites are listed on Table B-l. The available temperature data for some of the sites (OSU, Minam-Wallowa) is of short duration (O-4 months of record) and temperature data from another site was used for concept design. These sites were selected following the site screening evaluation and Tempmentors were only recently installed. In addition, the temperatures experienced in the project area for the past 6-12 month may have not been typical. Weekly temperature data that could potentially be used for each site is presented in this section.

While certain assumptions in the surface water temperatures at a site, and information gaps, can be accommodated at a conceptual level, this is not an acceptable situation for final design. It is strongly recommended that the current temperature collection be continued until the start of the final design. To maintain quality control over the temperature collection process, data reduction must be done as the data is collected. The Tempmentor data should be reduced into the following summary files in either Lotus123 or EXCEL format:

Daily temperature information (l/2 -1 hour intervals)

Daily maximum, minimum, and means

Monthly summaries.

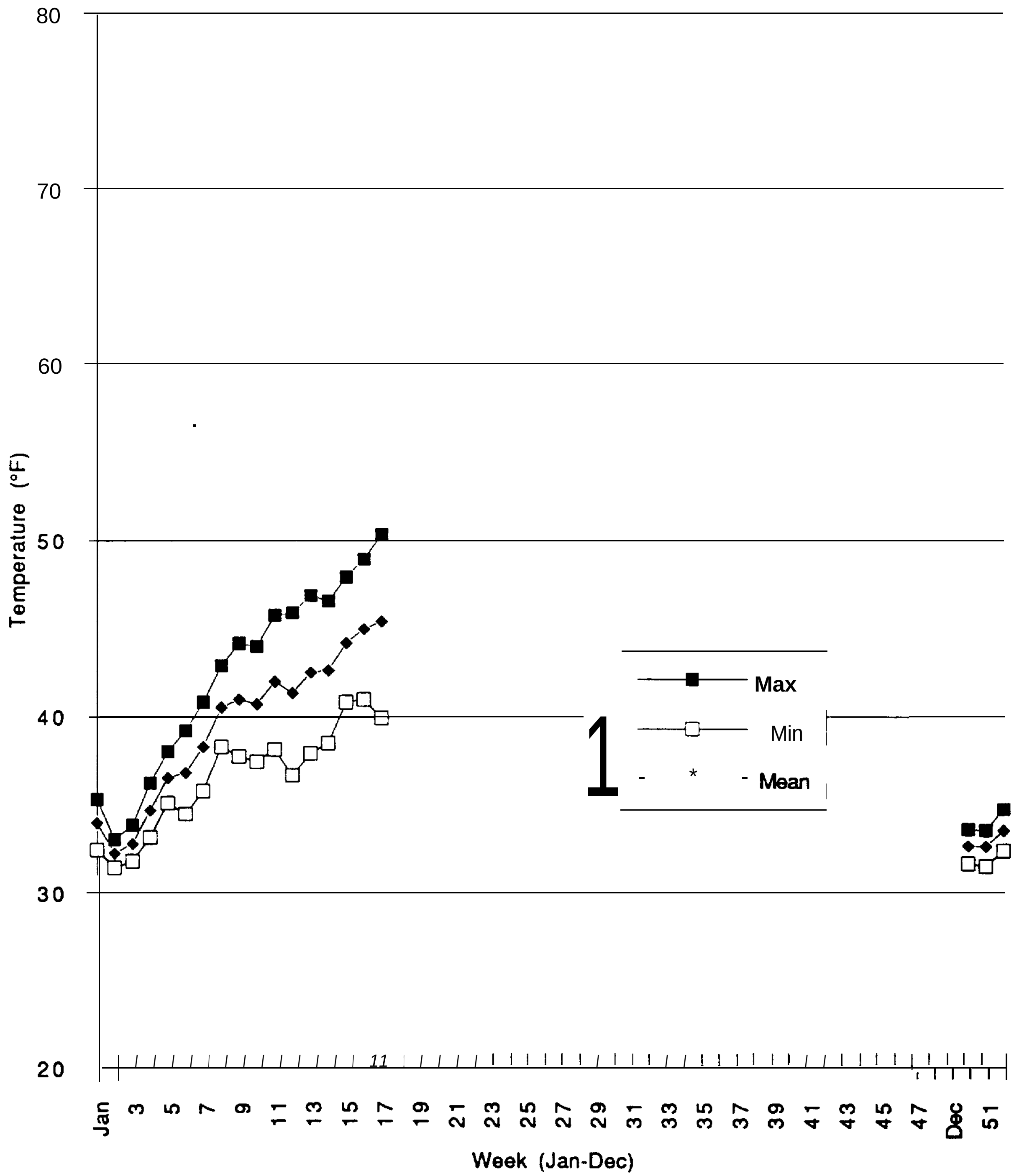
TABLE B-1

NEOH WATER TEMPERATURE RECORDER LOCATIONS:

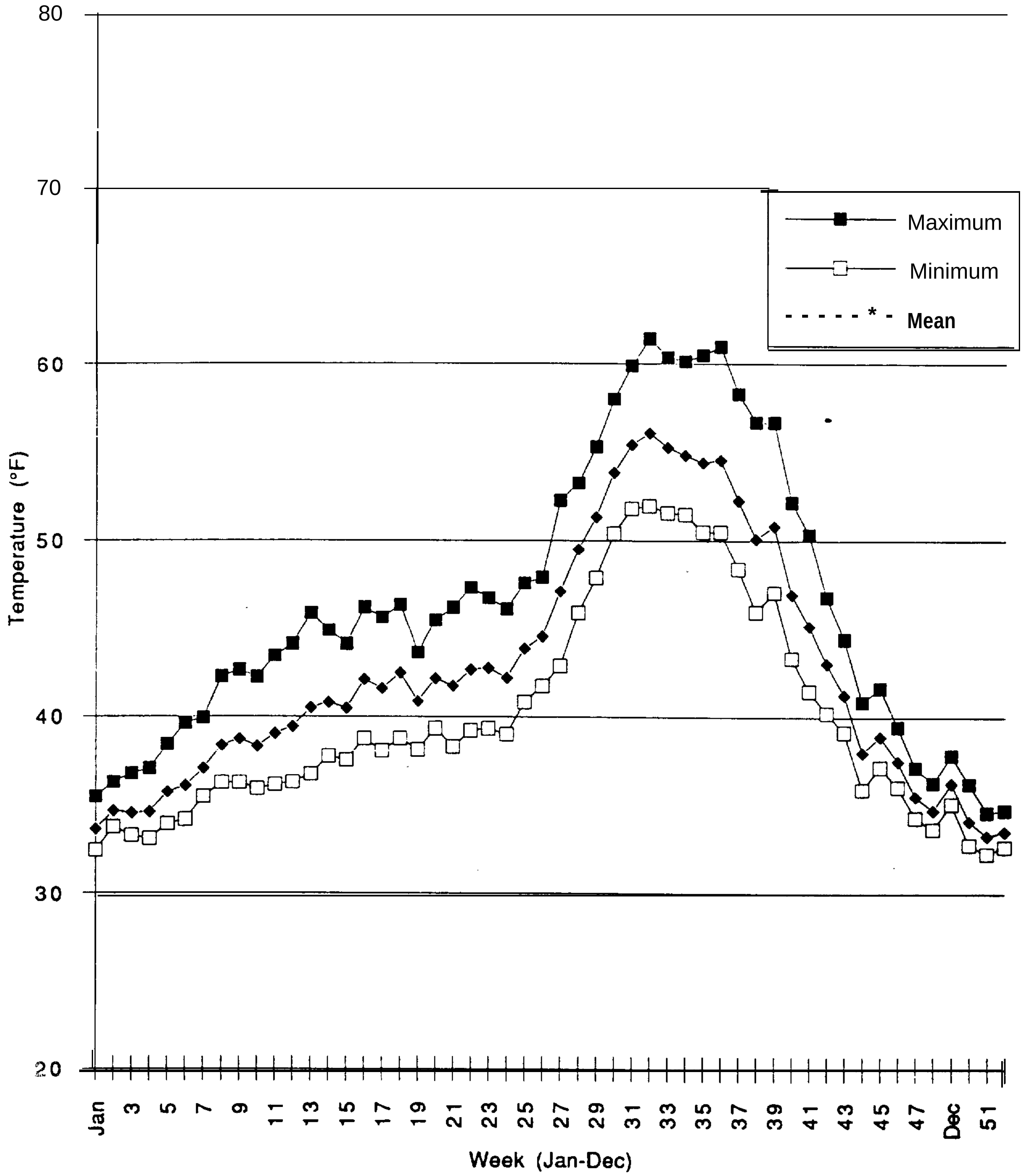
No.	Site	Temperature Station(s)	Type	Distance (mi)	Available Data Period	Selected Data
1	Catherine Ck @ Union	Catherine Ck	Tempmentor	<1	4 months	Lostine @ Strathern
2	OSU Site	Catherine Ck	Tempmentor	on site	4 months	Lostine @ Strathern
3	Strathearn Ranch	Lostine @ Strathearn Ranch	Tempmentor	on site	1.8 yrs	Lostine @
		Lostine @ Lostine	USGS	on site	1.5 yrs	Strathern
4	Wayne Marks Ranch	New recorder	Tempmentor	on site	none	Imnaha @ Imnaha
		Imnaha @ Imnaha	USGS	5	3.5 yrs	
		Marr Ranch	Tempmentor	10	1.5 yrs	
5	Minam-Wallowa	Minam	USGS	1	20 yrs	Minam
		Minam- Wallowa confluence	Tempmentor	<1	4 months	
6	Gene Marr Ranch	Marr Ranch	Tempmentor	on site	1.5 yrs	Marr Ranch
		Fall Ck	Tempmentor	on site	1.5 yrs	
7	Russell Walker	Walla Walla	USGS	1	2Yrs	Walla Walla
8	Harris Park #1	Walla Walla	USGS	on site	w-s	Walla Walla

Catherine Ck @
Union

Average Weekly Temperatures at Catherine Creek

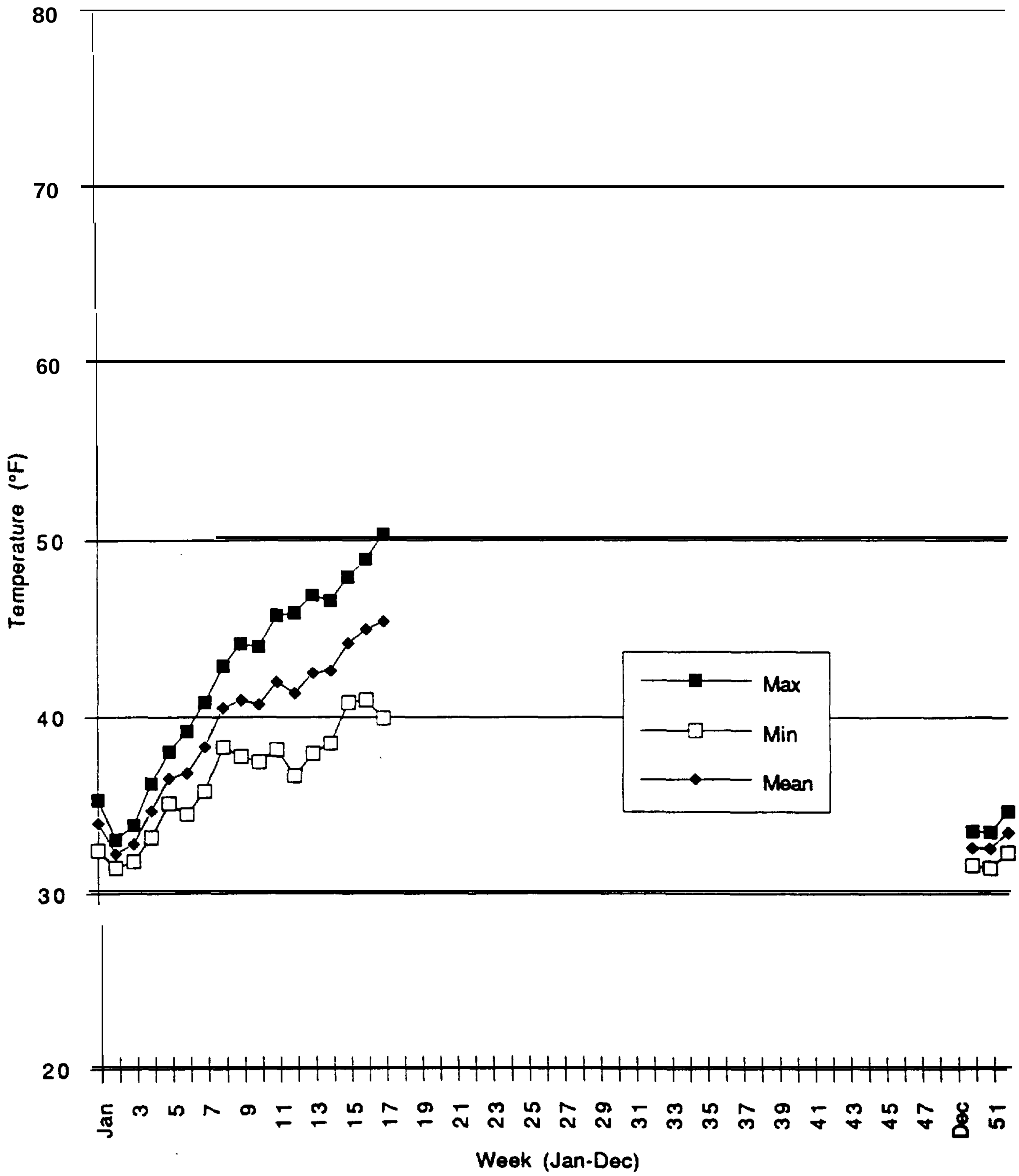


Average Weekly Temperatures at Strathearn Ranch (Lostine)

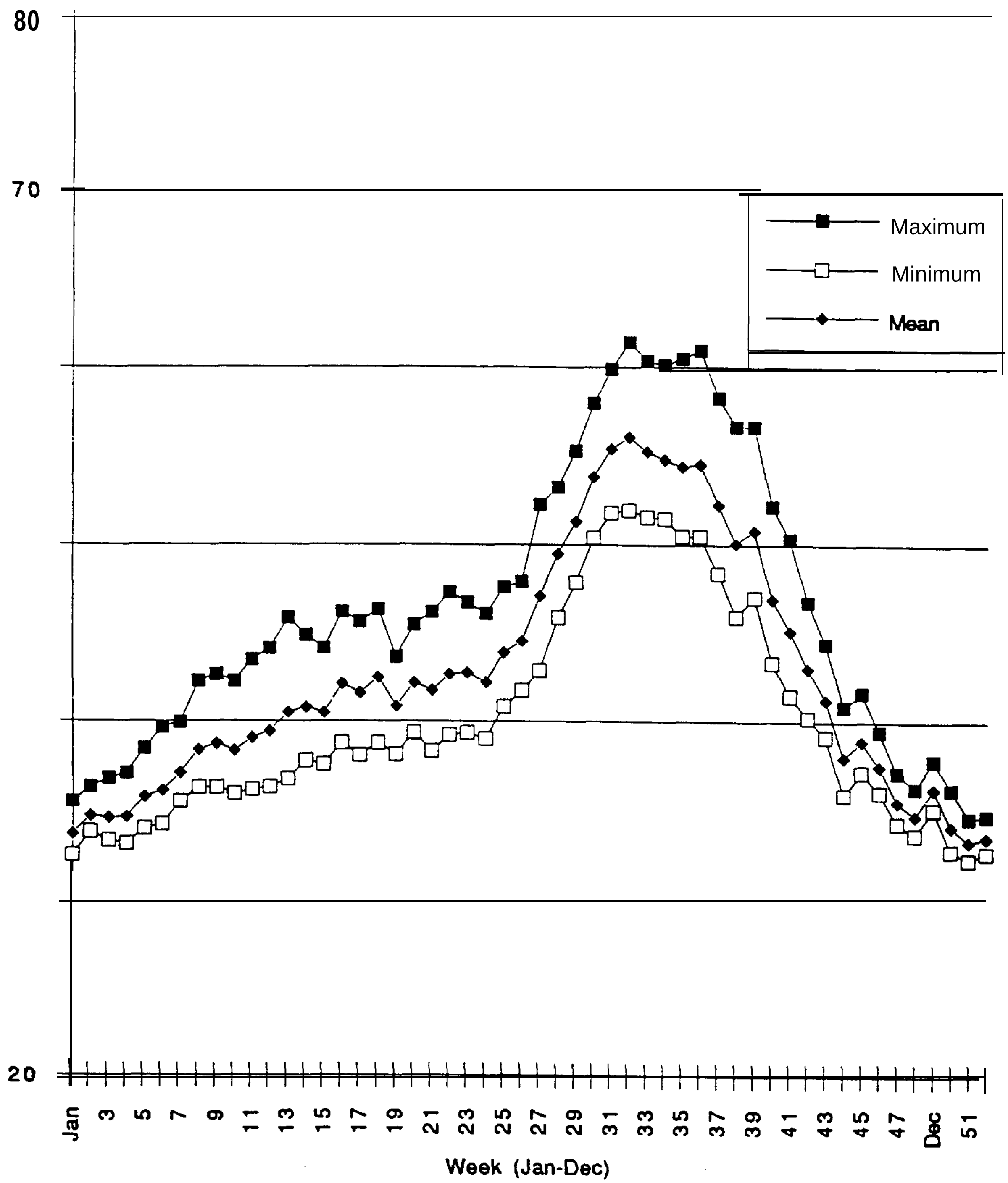


OSU Site

Average Weekly Temperatures at Catherine Creek

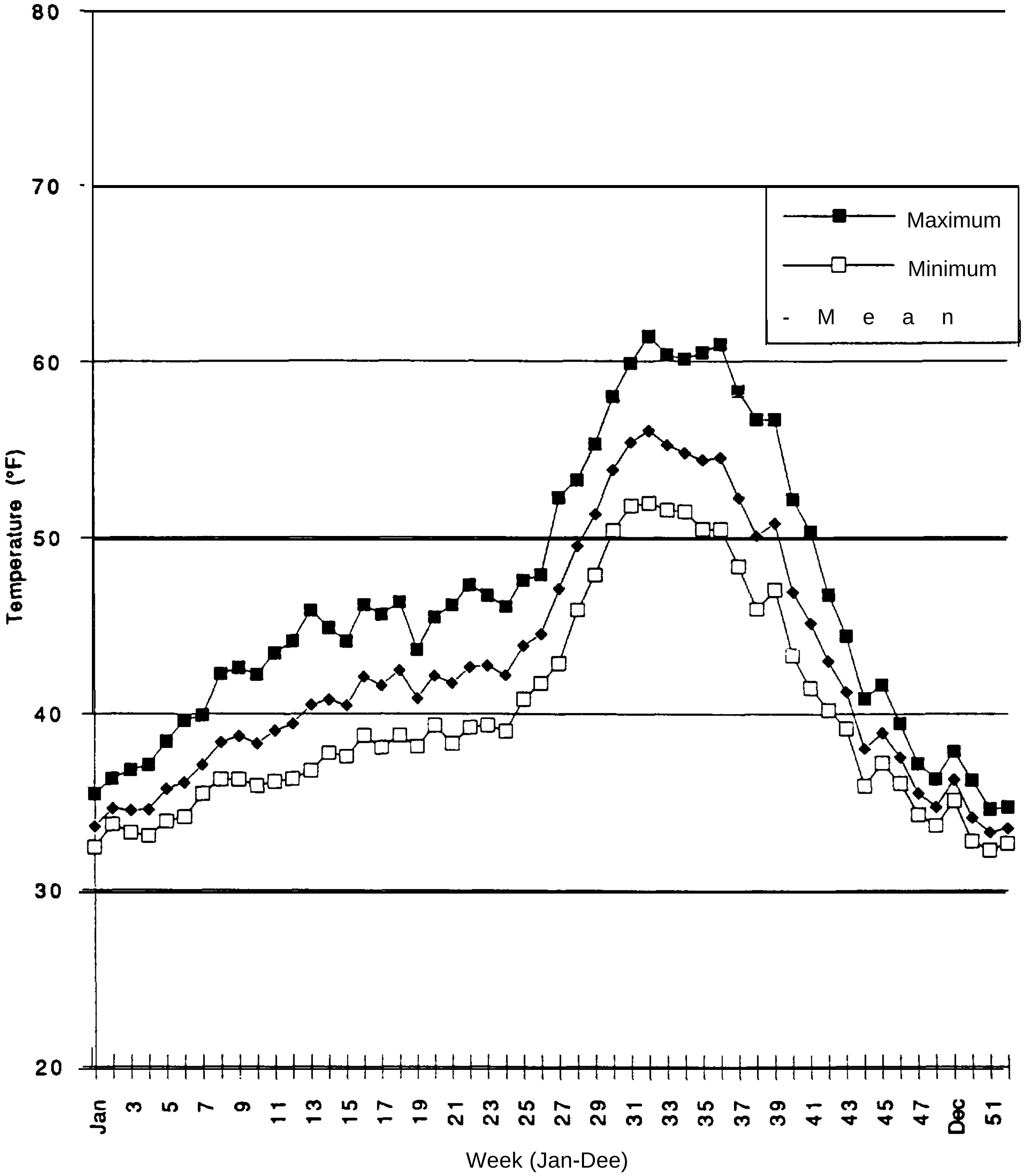


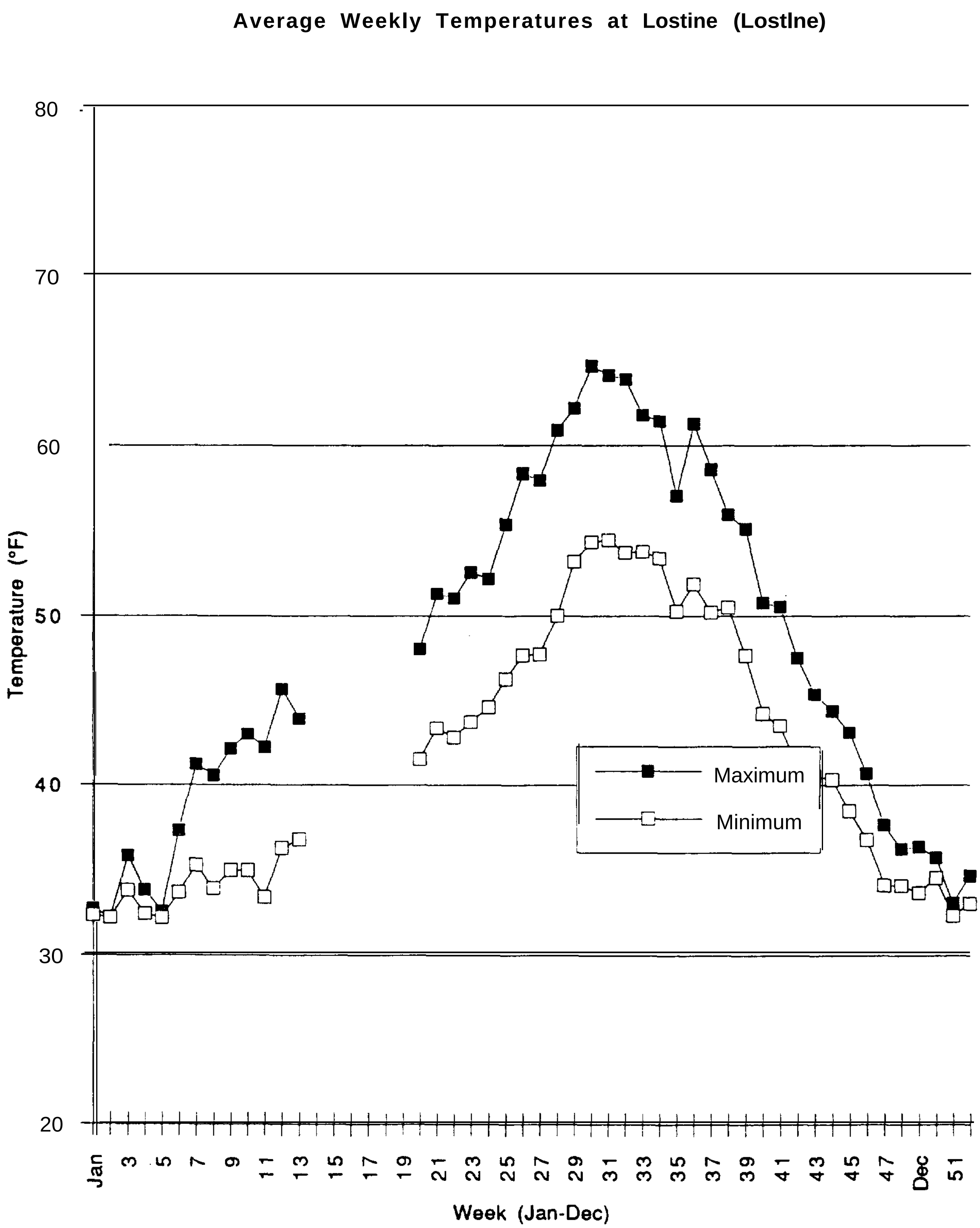
Average Weekly Temperatures at Strathearn Ranch (Lostlne)



Strathearn Ranch

Average Weekly Temperatures at Strathearn Ranch (Lostlne)

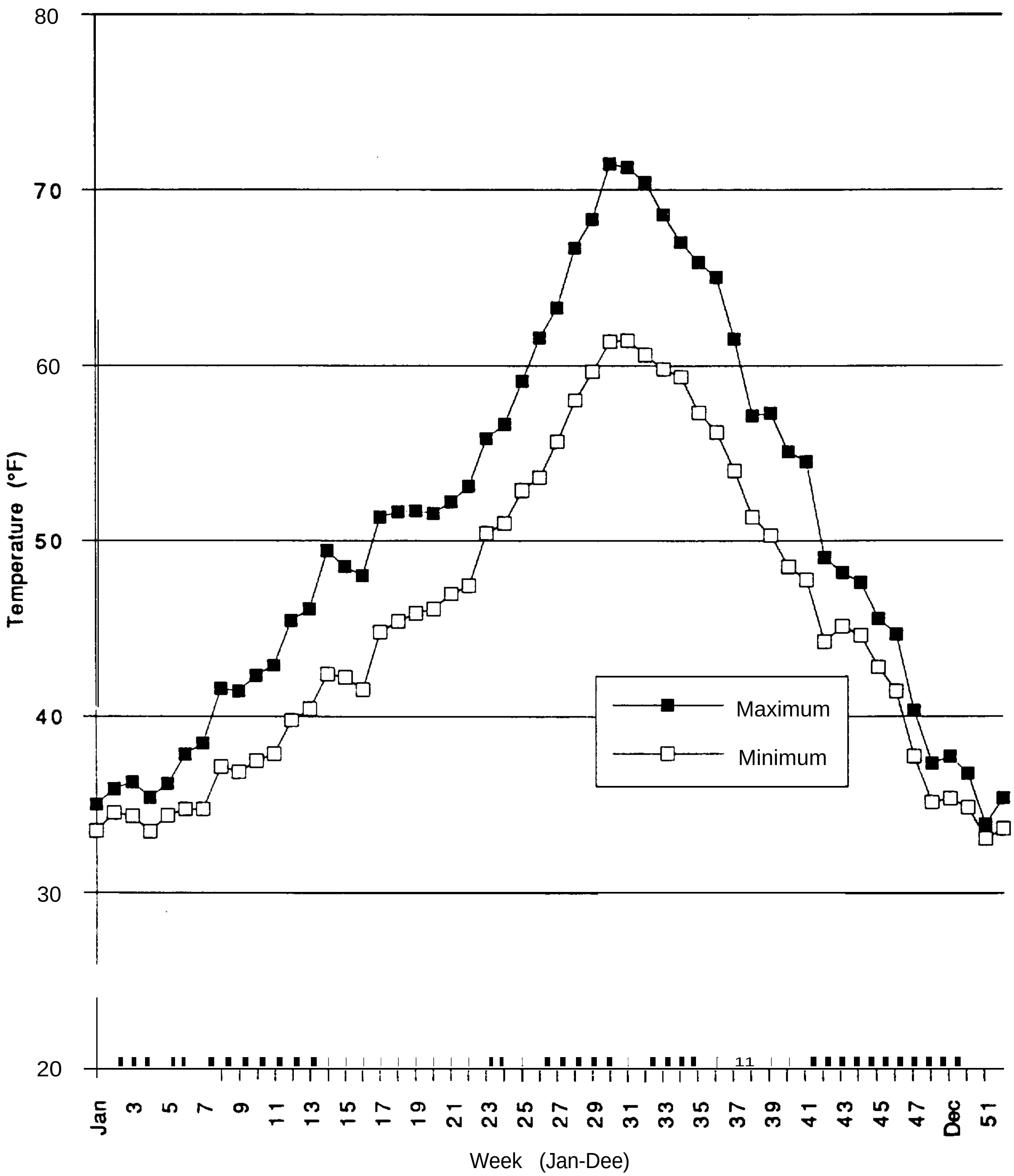




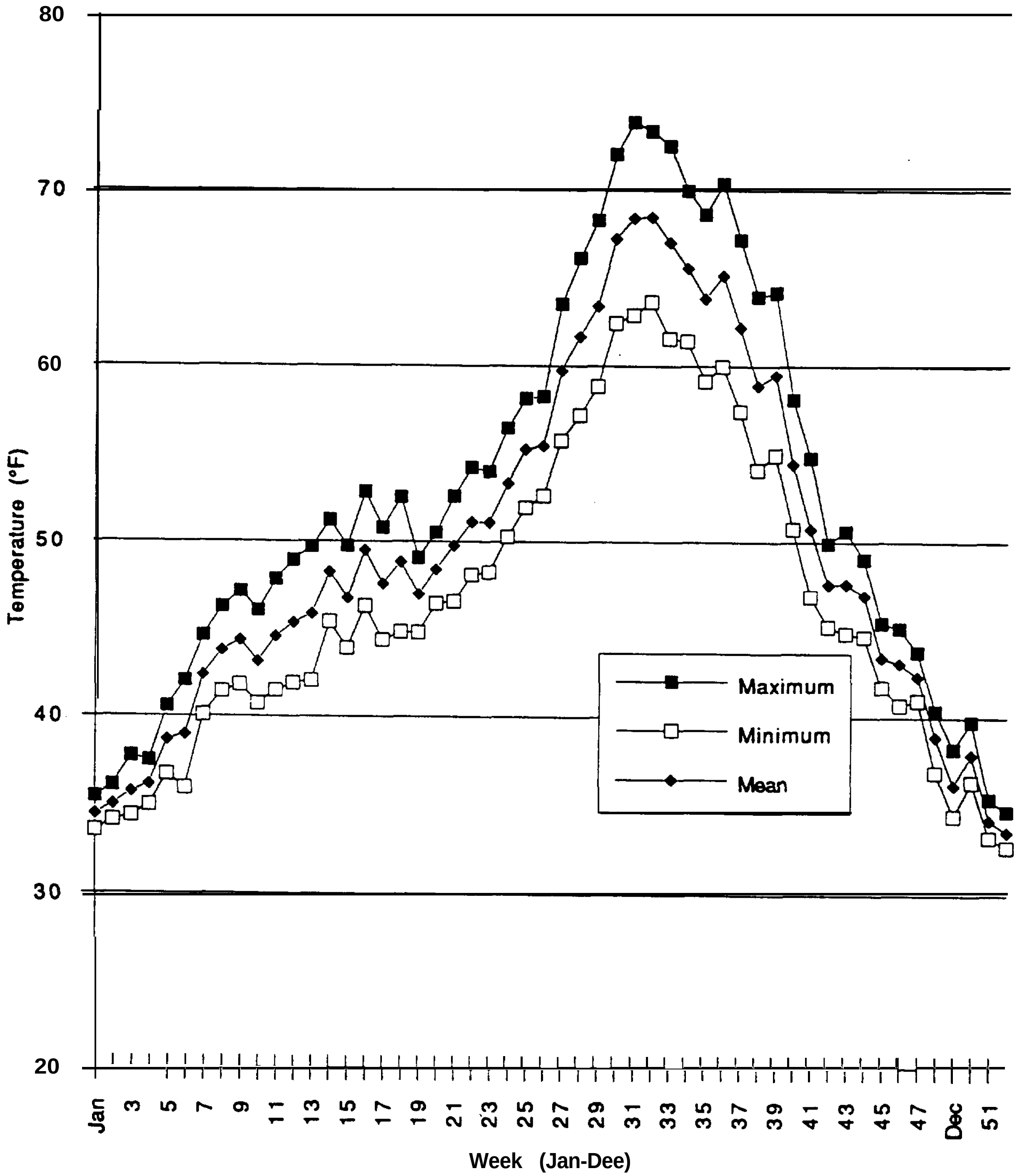
Average Weekly Temperatures at Lostine (LostIne)
Temperature (°F)
80
70
60
50
40
30
20
Maximum
Minimum
Jan
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Dec
51
Week (Jan-Dec)

Wayne Marks
Ranch

Average -Weekly Temperatures at Imnaha (USGS)

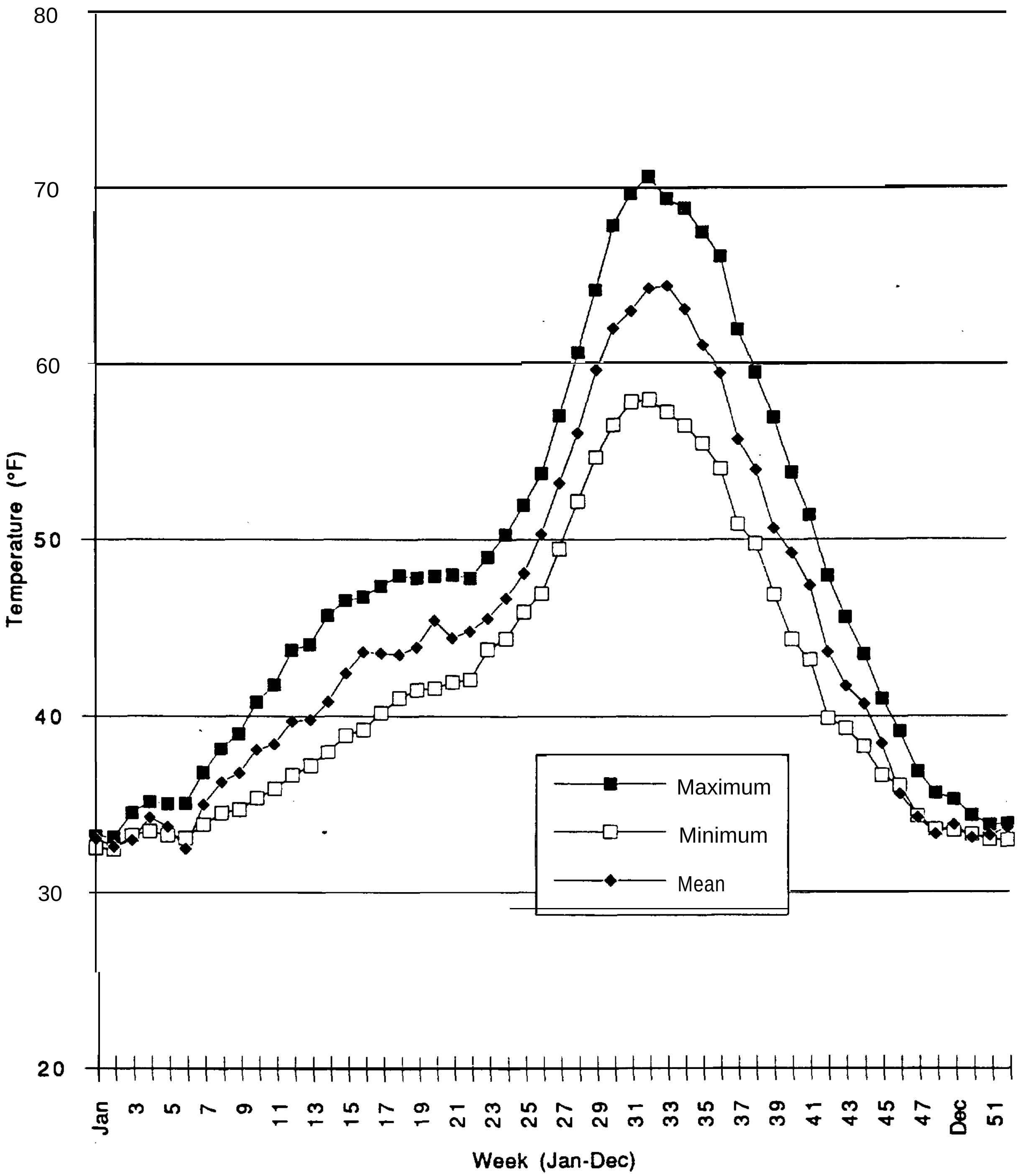


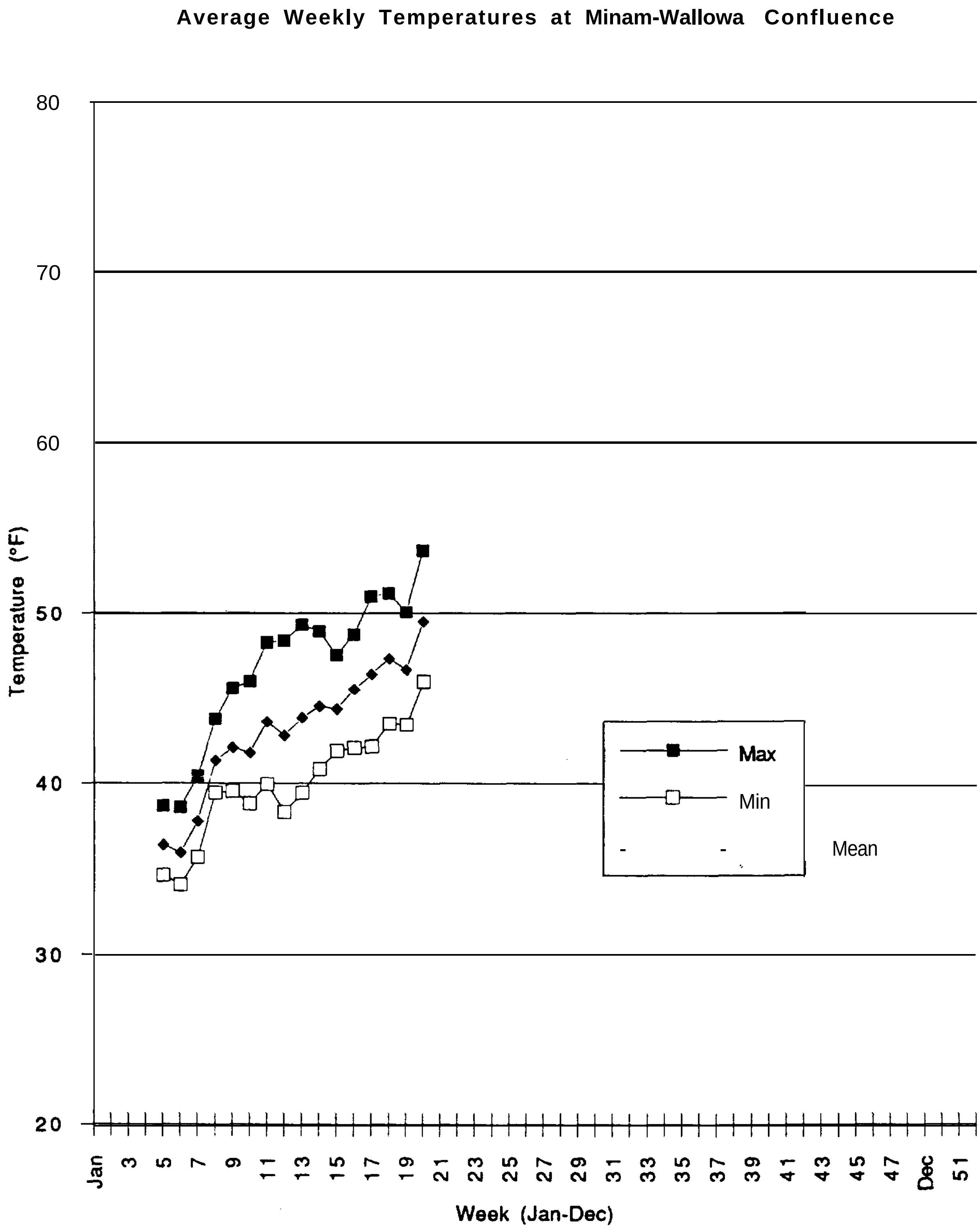
Average Weekly Temperatures at Marr Ranch (Imnaha)



Minam-Wallowa

Average Weekly Temperatures at MInam (USGS)

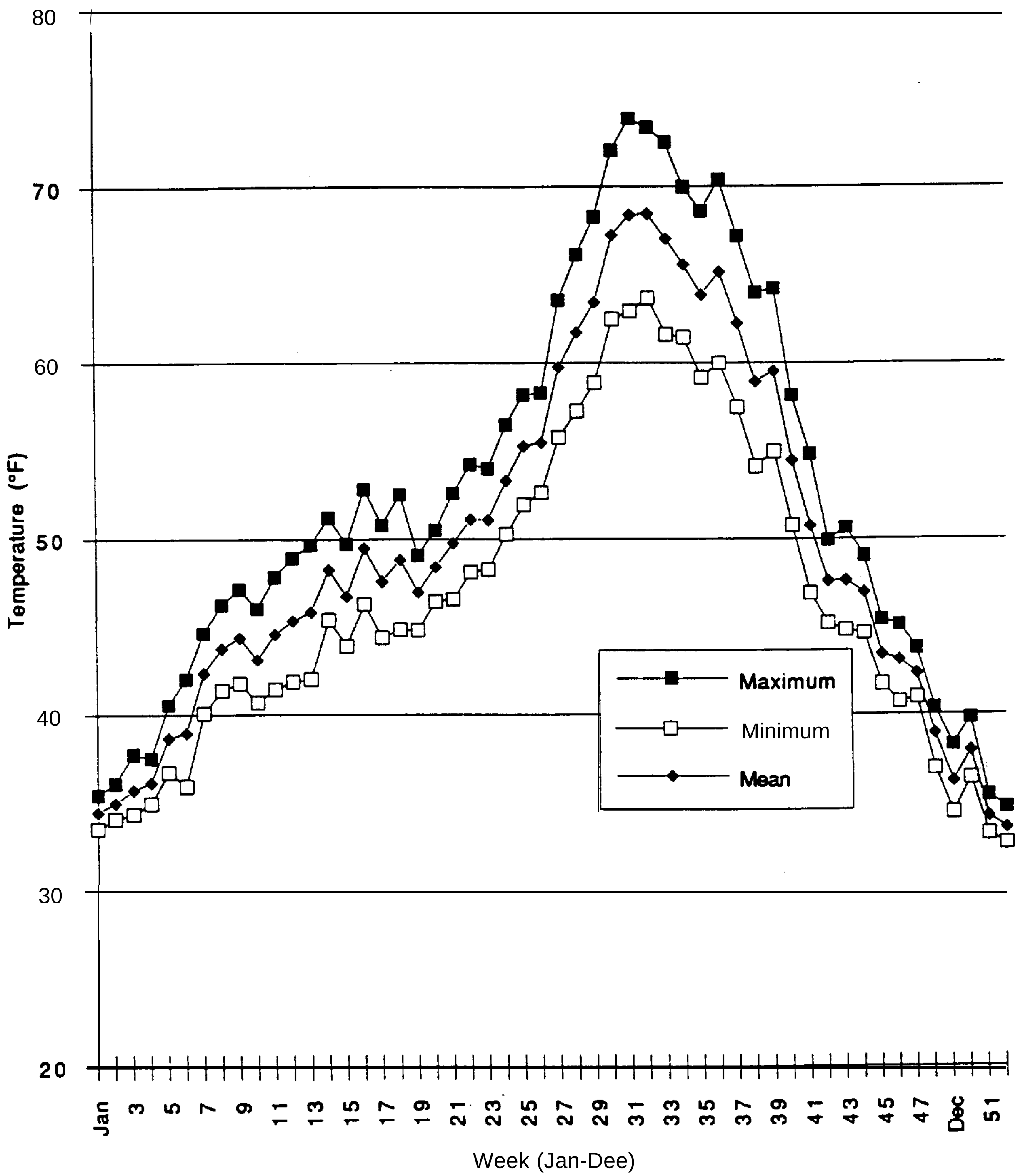




Average Weekly Temperatures at Minam-Wallowa Confluence
80
70
60
50
40
30
20
Temperature (°F)
Max
Min
Mean
Jan
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Dec
51
Week (Jan-Dec)

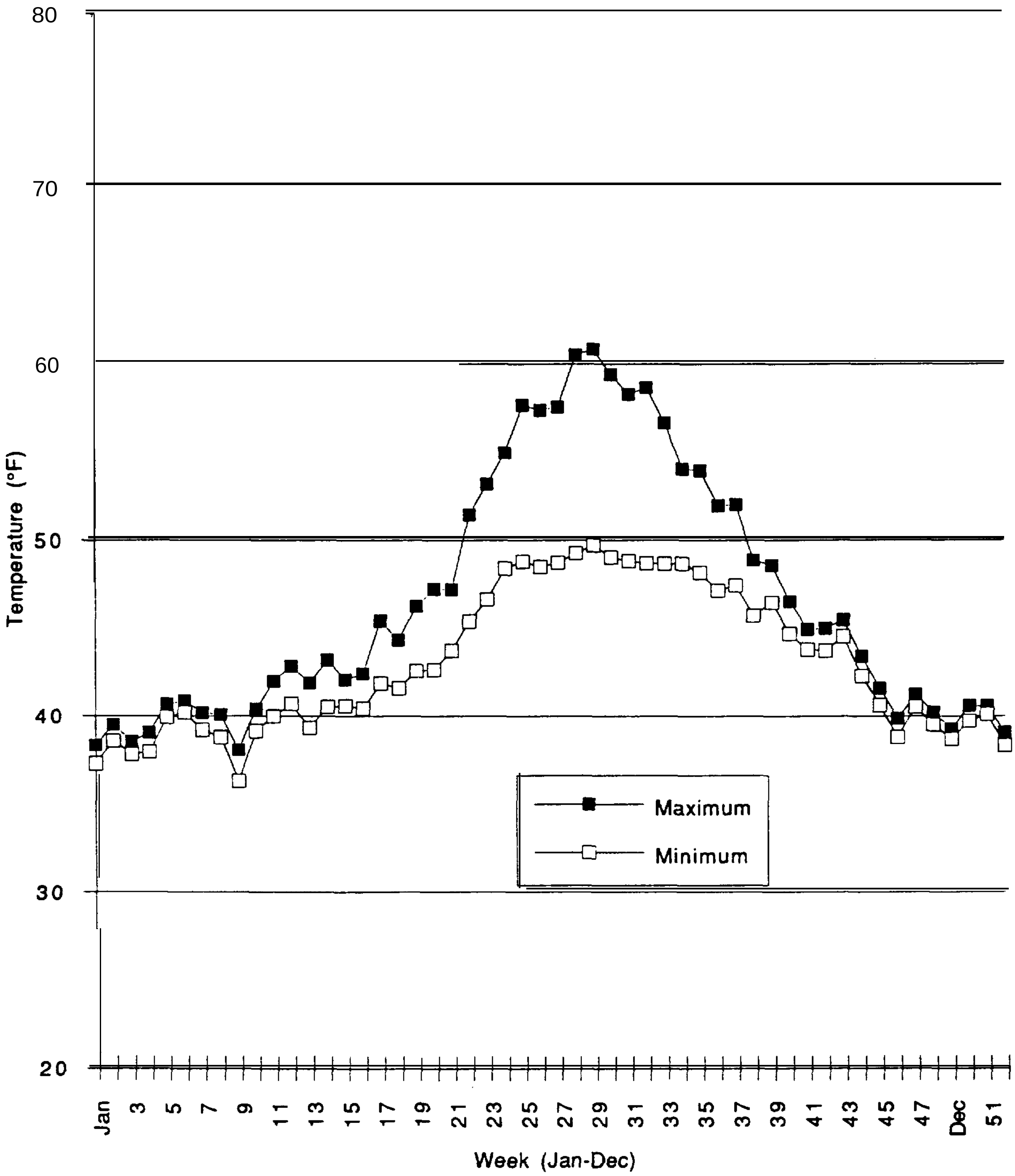
Gene Marr Ranch

Average Weekly Temperatures at Marr Ranch (Imnaha)



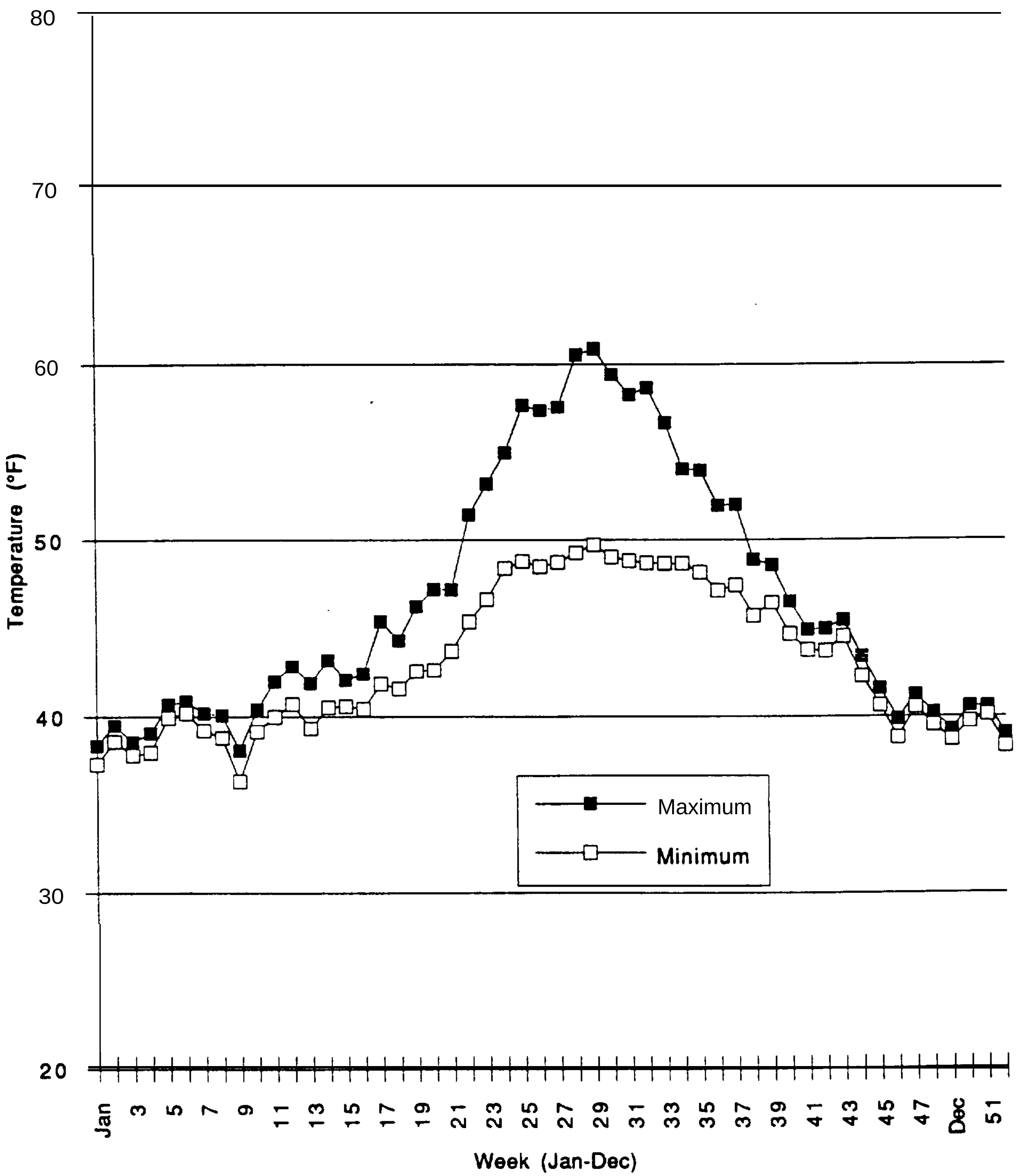
Russell Walker

Average Weekly Temperatures at Walla Walla (USGS)



Harris Park #1

Average Weekly Temperatures at Walla Walla (USGS)



APPENDIX C

TEST WELL DRILLING SUMMARY

M E M O R A N D U

MONTGOMERY WATSON

To:	Bill Blaylock	**Date:**	4-28-94
From:	Patrick Naylor	**Reference:**	NEOH
Subject:	**BPA Lostine River Test Well**		

INTRODUCTION

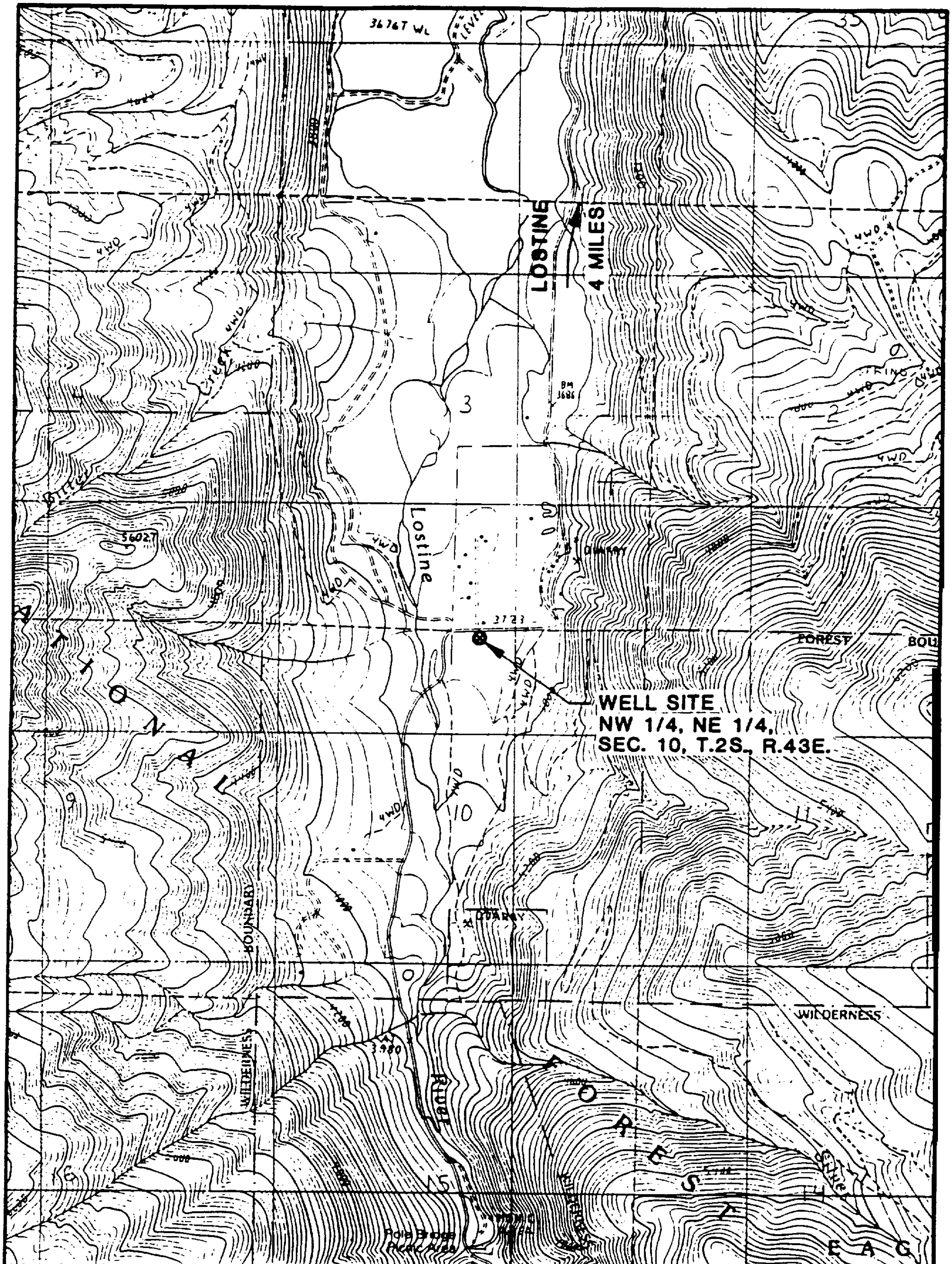
One test well has been drilled and capped at the Bighorn Sheep Range site on the Lostine River Road, NW1/4, NE1/4, Section 10, Township 2S, Range 43E, about four miles south of Lostine, Oregon (see Figure 1). The well was drilled to a total depth of 172 feet. The well was found to have sufficient production capacity for domestic purposes, but would have insufficient production capacity for the desired hatchery facility at this location.

HYDROGEOLOGY

The Bighorn Sheep Range site is in a glacially formed valley and overlies alluvial and glacial sedimentary deposits in the valley floor. The bedrock underlying the sediments is thought to be Triassic-age marine sedimentary rock. North (downstream) of the Bighorn Sheep Range, an east-west-trending fault separates the marine sediment bedrock from basalt. The marine sedimentary rock **is** upthrown relative to the basalt.

The drilling log for the test well differs somewhat from engineering descriptions of drilling grab samples. In some instances, such features as boulders would only be discernible while drilling, and establishment of these features are shown only on the drilling log. Other characteristics are probably better described in engineering descriptions of grab samples. Both the well driller's log and the engineering soil descriptions of grab samples indicate a combination of alluvial and glacial deposits from the surface to 162 feet, at which depth bedrock is encountered. Both logs also show that no significant water-bearing zones are present in the unconsolidated material. Note that the drilling method may have resulted in considerable mixing of cuttings, so that precise determinations of lithology are difficult. A summary engineering log of grab samples is found in Appendix A. The well driller's log is included in Appendix B.

The subsurface materials consist primarily of silty sand, sandy silt, sandy clay, and silt, **with** some gravely silt and boulders in the upper 100 feet. From about 105 feet to 155 feet, the soil is silt, fine sandy silt, or perhaps clay. The material in this interval was difficult to characterize, because the driller reports "heaving" throughout this interval, and only one grab sample was collected Heaving typically does not occur in silt or clay, and would only occur under saturated conditions. This is not completely consistent with the driller's determination that saturation was first encountered at 155 feet (note that static water level was subsequently measured at 45 feet), or with his description of the material as "sandy clay".



6IGHORN SHEEP **RANGE** TEST WELL SITE

FIGURE 1

However, even with some uncertainty about the exact nature of some intervals of unconsolidated material, it appears probable that only moderate groundwater production potential is available at this site. This was confirmed by a baildown test conducted by the driller. In a four-hour period, about 65 feet of drawdown occurred with a withdrawal rate of about 25 gpm. This represents a specific capacity of only about 0.4 gpm per foot of drawdown. This bail down test probably does not provide an accurate representation of yield from a properly completed well at this site, as the well was completed as an open bottom pipe set about 2 feet above bedrock, with no screens or perforations. A higher yield would be anticipated if the well had also tapped sand layers suspected to be present in the heaving interval of the borehole from 105 to 155 feet. Nonetheless, it is unlikely that a sustainable yield in excess of about 100 gpm could be obtained from the aquifer penetrated by the test well.

Logs for nearby domestic water wells (see Appendix C for well logs from Sections 3 and 10, T2S, R43E) suggested that the potential for groundwater production was somewhat more promising than those conditions encountered while drilling the test well would indicate. In particular, drill logs for the domestic wells located in the subdivision across the road from the test well site indicated the presence of a clean sand aquifer at a depth of approximately 100 to 120 feet. Specific capacity of several of these wells suggest potential yields from the aquifer in excess of 100 gpm. The reason for the change in subsurface conditions over a relatively small horizontal distance is unknown but may be related to fluvial channel deposits which may be more favorable for groundwater production in some areas than other, nearby areas. Other than drilling additional test holes, no reliable method exists for locating these channels of coarse-grained deposits, if they exist

The depth to bedrock had originally been expected to be deeper than 162 feet. Geophysical testing at the Stratheam Ranch, about two miles north of the Bighorn Sheep Range test well site, indicated that depth to bedrock was in excess of 300 feet. At this location, seismic refraction testing in April 1992 had indicated that bedrock was more than 300 feet below the surface. (Seismic testing was conducted at the Strathearn Ranch rather than the Bighorn Sheep Range because the Strathearn Ranch was the original preferred test site; the Bighorn Sheep Range was selected when the other site became unavailable.) Although some adjustment had been made for the slope of the bedrock below the unconsolidated overburden from the Strathearn Ranch site to the Bighorn Sheep Range site, the relatively shallow depth to bedrock had not been anticipated.

WELL DRILLING

Drilling operations began on February 26, 1994 and were completed on March 17, 1994. The well was drilled by Stoffel Brothers Drilling of Enterprise, using a cable tool drill rig. Grab samples of drill cuttings were collected at five foot intervals from the surface to 105 feet and from 155 to 165 feet. Only one sample was collected from 105 to 155 feet because of difficult sampling conditions and because the driller reports the material was essentially uniform across this interval.

A 12-inch temporary casing was installed from the surface to 10 feet. The boring was advanced at a 12-inch diameter to a depth of 23 feet; the clay soil matrix did not require casing to keep the 12-inch hole open from 10 to 23 feet. The well was advanced using g-inch diameter, 0.322" wall-thickness steel casing from the surface to a depth of 160 feet. Because no significant water-bearing zones were encountered above 160 feet during drilling, the casing was not perforated.

Bedrock was encountered at 162 feet. The boring was advanced to 172 feet to verify that bedrock and not a large boulder had been encountered.

The driller reported first encountering groundwater at 155 feet. The static water level in the casing subsequently rose to 45 feet below ground level. A 4-hour baildown test resulted in 65 feet of drawdown at a bailing rate of 25 gpm.

Drilling results and baildown testing indicated that the aquifer did not have adequate production potential to supply the 500 gpm required for a fish hatchery facility. Therefore, well screen was not installed, and no pumping tests or water quality tests were conducted. However, recognizing that BPA might elect to construct a facility at the site using a surface water source, the well was capped rather than abandoned. The rationale for this decision was that, should a facility be constructed at this location, the well could be completed as a drinking water supply. In the event that BPA decides not to construct a facility at this site, the well should be abandoned in accordance with Oregon regulatory requirements.

Capping was accomplished by welding a steel plate over the top of the casing. A one-inch diameter access port with a plug was cut and welded on the cap for future water level measurements.

A summary field log is provided in Appendix D.

CONCLUSIONS

The test well at the Bighorn Sheep Range near the Lostine River does not indicate that sufficient groundwater supply could be developed at this location to support a 500 gpm fish hatchery requirement. This was somewhat surprising, because nearby well logs suggested more promising conditions, and bedrock was anticipated to be somewhat deeper. It also appears unlikely that a wellfield of multiple wells supplying 500 gpm could be developed within a short distance of the site. As presently completed, it is unlikely that the well could sustain more than 30 to 40 gpm production for any significant length of time. The test well should provide an adequate supply of groundwater for drinking water purposes, if a facility were to be constructed at the site which utilized surface water for hatchery requirements.

It is possible that a sustainable groundwater supply in the range of 100 to 200 gpm could be developed by several wells open to the aquifer tapped by the domestic wells located north of the Bighorn Sheep Range site. An aquifer test using these domestic wells for pumping and observation would confum this potential. Additional test wells or aquifer tests are not warranted at this site if the groundwater requirement exceeds a few hundred gallons per minute.

LOSTINE RIVER TEST WELL
ENGINEER'S SUMMARY WELL LOG

DEPTH (FT)	DESCRIPTION
5	Sandy Silt - Dark brown, 20 percent fine sand, 5 percent medium sand, 5 percent coarse sand, 70 percent nonplastic fmes, ML, alluvium.
10	Silty Sand - Dark brown, 10 percent subrounded gravel, 20 percent fine subrounded sand, 20 percent medium subrounded sand, 20 percent coarse subrounded sand, 30 percent fines, SM. alluvium.
15	Silty Sand - Dark brown, 10 percent subrounded gravel, 15 percent fine subrounded sand, 15 percent medium subrounded sand, 20 percent coarse subrounded sand, 40 percent fines, SM, alluvi m.
20	Silty Sand - Dark brown, 10 percent subrounded gravel, 15 percent fine subrounded sand, 15 percent medium subrounded sand, 20 percent coarse subrounded sand, 40 percent fines, SM, alluvia.
25	Silty Sand - Dark brown, 15 percent gravel, 10 percent fine sand, 10 percent medium sand, 35 percent coarse sand, 30 percent fines, SM, **alluvium.**
30	Silty Sand - Dark brown, 15 percent gravel, 10 percent fine sand, 10 percent medium sand, 35 percent coarse sand, 30 percent fines, SM, **alluvium.**
35	Silty Sand/Sandy Silt - Very dark grayish brown, 10 percent subrounded gravel, 40 percent coarse subrounded sand, 50 percent nonplastic fines, sM/ML, alluvium.
40	Silty Sand - Very dark grayish brown, 30 percent subrounded gravel, 30 percent coarse subrounded sand, 40 percent fines, SM, alluvium
45	Silty Sand - Very dark grayish brown, 5'percent subrounded to subangular gravel, 70 percent coarse subrounded to subangular sand, 20 percent fines, SM, alluvium.
50	Silty Sand - Very dark grayish brown, 10 percent subrounded to subangular gravel, 70 percent coarse subrounded to subangular sand, 20 percent fines, SM, alluvium.

55	Sand - Very dark gray, 5 percent subangular to subrounded gravel, 40 percent fine sand, 30 percent medium subangular to subrounded sand, 25 percent coarse subangular to subrounded sand, SW, alluvium.
60	Sandy Gravely Silt - Very dark grayish brown, 20 percent rounded to subangular gravel and cobbles, 20 percent coarse rounded to subangular sand, 60 percent nonplastic fmes, ML, alluvium.
65	Sandy Clay - Dark grayish brown, 30 percent coarse angular sand, 70 percent moderately plastic fines, CL, glacial till or alluvium.
70	Sandy Clay - Dark grayish brown, 30 percent coarse angular sand, 70 percent moderately plastic fines, CL, glacial till or alluvium.
75	Sandy Silt - Very dark grayish brown, 30 percent coarse angular sand, 70 percent nonplastic fines, ML, glacial till or alluvium.
80	Sandy Silt - Very dark grayish brown, 30 percent coarse angular sand, 70 percent nonplastic fines, ML, glacial till or alluvium.
85	Sandy Clay - Very dark grayish brown, 10 percent subangular to angular gravel, 25 percent medium subangular to angular sand, 40 percent coarse subangular to angular sand, 75 percent moderately plastic fmes, CL, glacial till or alluvium.
90	Silty Sand - Very dark grayish brown,,10 percent rounded to subangular gravel, 25 percent medium rounded to subangular sand, 40 percent coarse rounded to subangular sand, 15 percent fines, SM, alluvium.
95	Silty Sand - Very dark grayish brown, 10 percent rounded to subangular gravel, 25 percent medium rounded to subangular sand, 40 percent coarse rounded to subangular sand, 15 percent fines, SM, alluvium.
100	Sandy Silt - Dark grayish brown, 5 percent subangular to angular gravel, 5 percent fine subangular to angular sand, 5 percent medium subangular to angular sand, 10 percent coarse subangular to angular sand., 75 percent nonplastic fines, ML, alluvium.
105-155	Silt - Very dark gray, 100 percent nonplastic fines, ML, alluvium.
160	Sandy Gravely Silt - Very dark grayish brown, 10 percent subrounded to rounded gravel, 10 percent coarse subrounded to rounded sand, 80 percent nonplastic fines, ML, alluvium.
162-172	Bedrock

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.76)

(START CARD) # 63210

(1) OWNER:
SUB Well Number 3009.0025
Name Bonneville Power Ad - Nick Harmony Watson
Address 161 Mallard Drive
City Boise State Idaho Zip 83706

(2) TYPE OF WORK:
☑ New Well ☐ Deepen Recondition ☐ Abandon .

(3) DRILL METHOD:
☐ rotary air .Rotary Mud,. Cable.
Other

(4) PROPOSED USE:.
Domestic ☐ Community ☐ Industrial ☐ Irrigation.
Thermal InJection Other. test

(5) BORE HOLE CONSTRUCTION:
Special Construction approval x No.. Depth of Completed ft.
Explosives used Yes Type Amount

HOLE Diameter	From	to	seal Material	from	To	Amount sack or pounds
I)		23	Cement Slurry	0	133	24 Sacks

How was seal placed: Method
Other
Backfill placed from ft. to ft. Material
Gravel placed from ft. to NONE ft. Size of

(6) CASING/LINER:

	Diameter	From	To	Gauge	steel	Plastic	Welded	Threaded
Casing:	8"	+1'	160	322				
						☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:		NONE			☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) 60'

PERFORATIONS/ SCREENS:
5 perforations Method
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
			NONE.			☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is .1 hour ..
☐ Pump ☑ Bailer ☐ Air 5 Flowing. Artesian

Yield gal/min	Drawdown	Drill stem at	time
25	65		4 hr
I			

Temperature of Water 48° Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

C-6

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude Longitude
Township N or S. Range 4 2/5 E or W WM
Section NW ¼ NE ¼
Tax Lot OVC Eagle & Wild Blocks Subdivision
Street Address of Well (or nearest address) Lostine River Lostine, Or

(10) STATIC WATER LEVEL;
ft. below land surface. Date 8-16-9
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES
Depth at which water was first found 155

From	To	Estimated Flow Rate	SWL
22	162	25	

(12) WELL LOG:
Ground elevation

Material	From	To	SWL
Top Soil		2	
Boulders (Large) Clay & Gravel	2	30	
Brown Clay Boulders Large Gravel	30	40	
Boulders Clay Sand & Gravel	40	52	
Boulders Compact Clay Sand	52	58	
Boulders & Gravel Water	58	62	
Dirty Sand Clay Mixed	62	100	
Brown Sand Clay Gravel	100	105	
Blue Sandy Clay Sticky	105	122	
Clay Large Gravel	122	162	4
Granite	162	172	4

Date started 7-3 7-94 Completed 16-94

(unbonded) Water Well Constructor Certification:
certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

WWC Number
Signed Date

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

WWC Number
Signed Robert W Stoffel Date 3-20-9

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STATE OF OREGON

JUL13 1992

4-47-5E

WATER WELL REPORT
(as required by ORS 537.165)

WATER RESOURCES DEPT.
SALEM, OREGON

(START CARD) # 58044

(1) OWNER: Well Number

Name Robert M Courtney
Address 403 Leone
City Enterprise State Or Zip 97828

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD:
☐ Rotary Air ☐ Rotary Mud ☑ Cable
☐ Other

(4) PROPOSED USE:
☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☑ No Depth of Completed Well 120 ft.
Explosives used ☐ YES ☑ No Type Amount

HOLE Diameter	From	To	SEAL Material	from	To	Amount sacks or pounds
10"	0	127	Cement Slurry		27	
	27	120				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
0 other
Backfill placed from ft. to None ft. Material
Gravel placed from ft. to ft. Size of gravel

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6"	+16	120	.250	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	NONE				☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) 6" 120'

(7) PERFORATIONS / SCREENS:
☑ Perforations Method Torch
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
100	120	6X4	40			☑	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☑ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
I.a	42		4 hr.

Temperature of Water 47° Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ other C-7
Depth of strata:

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude Longitude
Township 2S N or S. Range 43E E or
Section 3 SW ¼ SE ¼
Tax Lot 16 Block Subdivision
Street Address of Well (or nearest address) old Pete H...
Lostine River

(10) STATIC WATER LEVEL:
18 ft. below land surface. Date 7-
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:

Depth at which water was first found 98'

From	To	Estimated Flow Rate
98	120	40

(12) WELL LOG:
Ground elevation

Material	From	To
Top Soil	0	4
Boulders & Clay	4	32
Sand (Dirty)	32	98
Sand Clean	98	12[illegible]

Date started 7-3-92 Completed 7-9-92

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration ... ment of this well is in compliance with Oregon well construction standa... used and information reported above are true to my best knowledge a...

WWC Numb...
Signed Date

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration or abandonment ... performed on this well during the construction dates reported above. All ... during this time is in compliance with Oregon well construction standar... is true to the best of my knowledge and belief.

WWC NUM...
Signed Robert V Stifflof Date 7-9

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STATE OF OREGON

WATER WELL REPORT
as required by ORS 537.765)

(START CARD) # 21209

(1) OWNER: Well Number:
Name David LundQuist
Address P O Box 25
City Lostine State Ore Zip 97857

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☐ Rotary Air ☐ Rotary Mud ☑ Cable
☐ Other

(4) PROPOSED USE:
☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☐ No ☑ Depth of Completed Well 135 ft.
Explosives used Yes ☐ No ☑ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10	0	27	Cement Slurry	0	26	14 sacks
6	27	135				

How was seal placed: method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ other
backfill placed from 22 ft. to 29 ft. material Cement & Sand
gravel placed from ft. to ft size of gravel

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6	-16"	135	.280	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	None				☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) 135 (6")

(7) PERFORATIONS/SCREENS:
☑ Perforations Method Torch
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
115	135	6x4	40			☑	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☑ Pump ☐ Bailer ☐ Air ☐ Flowing artesian

Yield gal/min	Drawdown	Drill stem at	time
20	23		3hr.5

Temperature of water 48 Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other C-B
Depth of strata:

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude longiude
Township 2S N of S. Range 43E E or W.
section 3 NE ¼ SW ¼
Tax Lot 6216 Lot Block Subdivision
Street Address of Well for nearst address
Lostine River Rd

(10) STATIC WATER LEVEL:
22 ft. below land surface. Date 8-11
Artesian pressure lb. per square Inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found

From	To	Estimated Flow Rate
125	135	40

(12) WELL LOG: Ground elevation

Material	From	To
Brown Clay & Rock	0	38
Dirty Brown Sand	38	120
Clean Sand W/B	120	135

AUG 23 1990

Date started 8-9-90 Completed 8-11-90

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, altera abandonment of this well is in compliance with Oregon well cons standards. Materials used and information reported above are true to knowledge and belief.

WWC Number,
Signed Date

(bonded) Water well Constructor Certification:
I accept responsibility for the construction, alteration or aband work performed on this well during the construction dates reported at work performed during this time is in compliance with Oreg construction standards. This report is true to the best of my knowle belief.
WWC Number 5
Signed Robert V Stoffel Date 8-21-9

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JUN 1 ... 199...

4S/43E/...

STATE OF OREGON

WATER WELL REPORT

(as required by ORS 537.765)

WATER RESOURCES DEPT.
SALEM, OREGON

(STARTCARD) # ~~4202~~

(1) OWNER:

Well Number:

Name John W Dulin

Address PO Box 140

City Lostine OR State OR Zip 97857

(2) TYPE OF WORK:

☑ New Well ☐ Deepen ☐ Reconditionl 0 Abandon

(3) DRILL METHOD

☐ Rotary Air 0 Rotary Mud ☑ Cable

☐ other

(4) PROPOSED USE:

☑ Domestie 0 Community 0 Industrial 0 Irrigation

0 Thermal ☐ Injection 0 other

(5) BORE HOLE CONSTRUCTION:

Special Construction approval Yes ☐ No ☑ depth of completed Well 125 ft.

Explosives used Yes ☐ No ☑ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10	0	27	Cement Slurry	0	27	10 Sacks
6	27	125				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E

☐ Other

Backfill placed from 29 ft. to 27 ft. Material Sand & Cement

Gravel placed from ft. to ft. Size of gravel

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6	+1	125	.250	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	None				☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) 25

(7 PERFORATIONS/SCREENS:

☐ Perforations Method Torch

☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
105	125	7x4	40			☑	0
						0	0
						☐	0
						0	☐
						☐	☐
						☐	☐

(8 WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☑ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
30	16		1 hrs

Temperture of water 47°

Depth Artesian Flow Found

Was a water analysis done? ☐ Yes By whom

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other

Depth of strata:

C-9 —

(9) LOCATION OF WELL by legal description:

County Wallowa Latitude Longitude

Township 2S N or S, Range 43E E or W

Section 3 SW ¼ SE ¼

Tax Lot Lot Block Subdivision

Street Address of Well (or nearest address) Lot 17 Old Ra... Subdivision

(10) STATIC WATER LEVEL:

14 ft. below land surface. Date 6-8

Artesian preasure lb. per square inch. Date-

(11) WATER BEARING ZONES:

Depth at which water was first found

From	To	Estimated Flow Rate
93	125	40 gpm

(12) WELL LOG:

Ground elevation

Material	From	To
Top Soil	0	4
Boulders Brown Clay	4	27
Dirty Brown Sand	27	94
Clean Granite Sand W/B	94	125

Date started 6-4-90 Completed 6-8-90

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, alter... abandonment of this well is in compliance with Oregon well cons... standards. Materials used and information reported above are true to... knowledge and belief.

WWC Number

Signed Date

(bonded) Water Well Constructor Certification:

I accept responsibility for the construction, alteration, or aband... work performed on this well during the construction dates reported a... work performed during this time is in compliance with Oreg... construction standards. This report is true to the best of my knowle... belief.

WWC Number 4...

S & d Robert V Stoffel Date 6-8-9...

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STATE OF OREGON
WATER WELL REPORT WALL 602
(as required by ORS 537.765)

2S/45E13

(START CARD) # 14744

(1) OWNER: Well Number:
Name Bruce Schmidt
Address Box 111
City Lostine State Or Zip 97857

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☐ Rotary Air ☐ Rotary Mud ☑ Cable
☐ Other

(4) PROPOSED USE:
☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☐ No ☑ Depth of Completed Well 103 ft.
Explosives used Yes ☐ No ☑ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10	0	28	Cement Slurry	0	27	11 Sacks
6	28	103				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other
Backfill placed from 22 ft. to 28 ft. Material Sand & Cement
Gravel placed from ft. to ft. Size of gravel

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6	-16	103	.250	☑	☐	☑	☐
Liner:					☐	☐	☐	☐

Final location of shoe(s) 103

(7) PERFORATIONS/SCREENS:
☑ Perforations Method Torch
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
93	103	1/4 x 4	40			☑	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☑ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
40	32		1 hr.

Temperature of water 41° Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other C-10
Depth of strata:

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude Longitude
Township 2S N or S. Range 45E E or W.
section 13 SW 1/4 SE 1/4
Tax Lot Lot Block Subdivision
Street Address of well (or nearest address) Old Pats Addi

(10) STATIC WATER LEVEL:
14 ft. below land surface. Date 5-1
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found

From	To	Estimated Flow Rate
96	103	50

(12) WELL LOG: Ground elevation

Material	From	To
Top Soil	0	5
Boulders & Clay	5	19
Dirty Sand	19	96
Clean W/B Sand	96	103

Date started 5-7-90 Completed 5-10-90

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, altera abandonment of this well is in compliance with Oregon well const standard materials used and information reported above are true to knowledge and belief.
WWC Number
Signed Date

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, altertion, or aband work performed on this well during the construction dates reported at work performed during this time is in compliance with Oregon construction standarda. This report is true to the best of my knowled belief.
WWC Number 4
Signed Robert V Steffel Date 5-10-9

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STATE OF OREGON
WATER WELL REPORT
(as required by OR9 597.755)

WALL Ui

2S/43E/3

(START CARD) # 19745

(1) OWNER:
Well Number:
Name Myrtle E Ellsworth
Address PO Box 24
City Lostine State OR Zip 97857

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☐ Rotary Air ☐ Rotary Mud ☑ Cable
☐ Other

(4) PROPOSED USE:
☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☐ No ☑ Depth of Completed Well 120 ft.
Explosives used Yes ☐ No ☑ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10	0	29	Cement Slurry	0	27	12 Sacks
6	29	120				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other
Backfill placed from 27 ft. to 30 ft. Material Sand
Gravel placed from ft. Size of gravel

(6) CASING/LINE:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6	+16	120	.250	☑	☐	☑	☐
Liner:	NONE							

Final location of shoe(s) 120

(7) PERFORATIONS/SCREENS:
☑ Perforations
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
100	120	1/4x4	40			☑	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☑ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
30	36		2hrs.

Temperature of water 46° Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other C-11
Depth of strata:

5

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude Longitude
Township 2S N or S, Range 43E E or W.
Section 3 SW ¼ SE ¼
Tax Lot 2000 Lot Block Subdivision
Street Address of well (or nearest address) Old Parks Sub

(10) STATIC WATER LEVEL:
16 ft. below land surface. Date 5-[illegible]
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found

From	To	Estimated Flow Rate
100	120	50

(12) WELL LOG:
Ground elevation

Material	From	To
Boulders & Clay	0	29
Sand Dirty	29	103
Clean Sand W/B	103	120

Date started 5-3-90 Completed 5-7-90

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, altera[tion, or] abandonment of this well is in compliance with Oregon well cons[truction] standards. Materials used and information reported above are true to [the best of my] knowledge and belief.
WWC Number
Signed Date

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or aband[onment] work performed on this well during the construction dates reported a[bove. All] work performed during this time is in compliance with Oreg[on well] construction standards. This report is true to the best of my knowle[dge and] belief.
WWC Number 4[illegible]
Signed Robert V Steffel Date 5-7-9[illegible]

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STATE OF OREGON
WATER WELL REPORT
AS required by OBB o r s

WATER RESOURCES DEPT.
SALEM. OREGON

2S/43E/3

(S T A R T C A R D) # m & w -

(1) OWNER: Well Number
Name Raymond L & Donna L Goebel
Address PO Box 117
City Lostine stete OR zip 97857

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☐ Rotary Air ☐ Rotary Mud ☑ Cable
☐ Other

(4) PROPOSED USE:
☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☐ No ☑ Depth of completed well ft.
Explosives used Yes ☐ No ☑ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10	0	27	Cement Slurry	0	27	18 Sacks
6	27	122				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other
Backfill placed from 30 ft. to 27 ft. Material Sand
Gravel placed from ft. to ft. size of gravel

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6	-16	122	.250	☑	☐	☐	☐
Liner:	None							

Final location of shoe(s) 122

(7) PERFORATIONS/SCREENS:
☑ Perforations Method Torch
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
100	120	3/8 x 6	40			☑	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☑ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
40	12		1 hr.

Temperature of water 46° Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

C-12

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude Longitude
Township 2S N or S, Range 43E E or W
Section 3 SW ¼ SE ¼
Tax Lot 1400 Lot Block Subdivision
Street Address of well (or nearest address) Lostine River old Cats Add.

(10) STATIC WATER LEVEL:
17 ft. below land surface. Date 12-11
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found

From	To	Estimated Flow Rate
100	120	LB

(12) WELL LOG: Ground elevation

Material	From	To
Top Soil	0	2
Brown Clay & Boulders	2	30
Dirty Sand & Gravel	30	98
Sand & Gravel W/B	98	120

Date started 12-6-89 Completed 12-11-89

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.
WWC Number
Signed Date

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 5
Signed Robert V Stoffel Date 12-11-89

ORIGINAL & FIRST COPY. WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER

STATE OF OREGON
WATER WELL REPORT
AS REQUIRE by ORS 537.765)

DEC 11 1989

2S/43E/3

(START CARD) # 19735

WATER RESOURCES DEPT.
SALEM, OREGON

(1) OWNER: Well Number
Name Harry Bagwell
Address PO Box 71
City Lostine State OR Zip

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☐ Rotary Air ☐ Rotary Mud ☑ Cable
☐ Other

(4) PROPOSED USE:
☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☐ No ☑ Depth of Completed Well ___ ft.
Explosives used Yes ☐ No ☑ Type ___ Amount ___

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10	0	27	Cement Slurry	0	27	19 Sacks
6	27	118				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other
Backfill placed from 50 ft. to 27 ft. Material Sand
Gravel placed from ___ ft. to ___ ft. Size of gravel ___

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6	+16"	118	.250	☑	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	NONE				☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) 118' (6")

(7) PERFORATIONS/SCREENS:
☑ Perforations Method torch
☐ Screens Type ___ Material ___

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
98	118	4X4	40			☑	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☑ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
25	12		1 hr.

Temperature of water 46° Depth Artesian Flow Found ___
Was a water analysis done? ☐ Yes By whom ___
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ___ C-13
Depth of strata: ___

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude ___ Longitude ___
Township 2S N or S, Range 43E E or W.
Section 3 SW ¼ SE ¼
Tax Lot 100 Lot ___ Block ___ Subdivision ___
Street Address of Well (or nearest address) Lostine River Rd

(10) STATIC WATER LEVEL:
21 ft. below land surface. Date 12-5
Artesian pressure ___ lb. per square inch. Date ___

(11) WATER BEARING ZONES:
Depth at which water was first found ___

From	To	Estimated Flow Rate
102	118	60gpm

(12) WELL LOG: Ground elevation ___

Material	From	To
Top Soil	0	3
Boulders & Clay	3	36
Dirty Sand & Gravel	36	102
Clean Sand & Gravel W/B	102	118

Date started 11-29-89 Completed 12-5-89

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, altera... abandonment of this well is in compliance with Oregon well const... standards. Materials used and information reported above are true to... knowledge and belief.
WWC Number ___
Signed ___ Date ___

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or aband... work performed on this well during the construction dates reported ab... work performed during this time is in compliance with Oreg... construction standards. This report is true to the best of my knowle... belief.
WWC Number 4...
Signed Robert V Stoffel Date 12-6-89

are to be filed with the
WATER RESOURCES DEPARTMENT.
SALEM, OREGON 97310
within 30 days from the date
of well completion.

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

State Well No. 2c 143e-3
State Permit No.

(1) OWNER:
Name High Lostine Limited Partnership
Address Lostine Ore

(2) TYPE OF WORK (check):
New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☑ Jetted ☐
D ☐ Bored ☐

(4) PROPOSED USE (check):
Domestic ☐ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☑ Other ☐

(5) CASING INSTALLED: Threaded ☐ Welded ☑
6 " Diam. from 0 ft. to 56 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS: Perforated? ☑ Yes ☐ No.
Type of perforator used Torch
Size of perforations 4 in. by 4 in.
40 perforations from 36 ft. to 56 ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS: Well screen installed? ☐ Yes ☑ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "
Bailer test 4 gal./min. with 30 ft. drawdown after 2 hrs.
Artesian flow g.p.m.
Temperature of water 48 Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used Cement Slurry
Well sealed from land surface to 25 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal 15 sacks
How was cement grout placed? Pumped from
Bottom of 10" Hole

Was a drive shoe used? ☑ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☑ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☑ No Size of gravel:
Gravel placed from ft. to ft.

C-1

(10) LOCATION OF WELL:
County Wallowa Driller's well number
SW ¼ SE ¼ Section 3 T. 2S R. 43E W.M.
Bearing and distance from section or subdivision corner
SW¼ SE¼ Sec 3

(11) WATER LEVEL: Completed well.
Depth at which water was first found 42
Static level 40 ft. below land surface. Date 8-27-
Artesian pressure lbs. per square inch. Date

(12) WELL LOG: Diameter of well below casing 6
Depth drilled 122 ft. Depth of completed well 122
Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
Clay & Boulders	0	46	
Granite Boulders	46	67	4
Granite (Grey)	67	122	4

RECEIVED
AUG 31 1979
WATER RESOURCES DEPT.
SALEM, OREGON

Work started 8-6 1979 Completed 8-27 19
Date well drilling machine moved off of well 8-28 19

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Robert V Stoffel (Drilling Machine Operator) Date 8-28, 19
Drilling Machine Operator's License No. 349

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name Stoffel Bros Drilling Co (Person, firm or corporation) (Type or print)
Address P.O. Box 32 Lostine, Ore
[Signed] Robert V. Stoffel (Water Well Contractor)
Contractor's License No. 415 Date 8-28, 19

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*4565

The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

WATER WELL REPORT

STATE OF OREGON

(Please type or print)

(Do not write above this line)

RECEIVED JUL 23 1973 STATE ENGINEER SALEM OREGON

State Well No. 2/45-3

State Permit No.

(1) OWNER:

Name M D McLain

Address Box 157 Lostine Ore

(2) TYPE OF WORK (check):

New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:

Rotary ☐ Driven ☐
Cable ☑ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):

Domestic ☑ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) CASING INSTALLED:

Threaded ☐ Welded ☑

6" Diam. from 0 ft. to 121 ft. Gage 250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(6) PERFORATIONS:

Perforated? ☑ Yes ☐ No.

Type of perforator used Torch

Size of perforations 1/7 in. by 4 in.

40 perforations from 100 ft. to 121 ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS:

Well screen installed? ☐ Yes ☑ No

Manufacturer's Name

Type Model No.

Diam. Slot size Set from ft. to ft.

Diam. Slot size Set from ft. to ft.

(8) WELL TESTS:

Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☑ No If yes, by whom?

Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "

Bailer test 40 gal./min. with 13 ft. drawdown after 1 hrs.

Artesian flow g.p.m.

Temperature of water 53° Depth artesian flow encountered - ft.

(9) CONSTRUCTION:

Well seal—Material used Bentonite Slurry

Well sealed from land surface to 21 ft.*

Diameter of well bore to bottom of seal 10 in.

Diameter of well bore below seal 6 in.

Number of sacks of cement used in well seal sacks

Number of sacks of bentonite used in well seal 3 sacks

Brand name of bentonite Premium Gel

Number of pounds of bentonite per 100 gallons of water 100 lbs./100 gals.

Was a drive shoe used? ☑ Yes ☐ No Plugs Size: location ft.

Did any strata contain unusable water? ☐ Yes ☑ No

Type of water? depth of strata

Method of sealing strata off

Was well gravel packed? ☐ Yes ☑ No Size of gravel:

Gravel placed from ft. to ft.

(10) LOCATION OF WELL:

County Wallowa Driller's well number

¼ ¼ section 3 T. 2 S R. 45E W.M.

Bearing and distance from section or subdivision corner

Block 19 15' w 87' s from NE Corner

(11) WATER LEVEL: Completed well

Depth at which water was first found 32

Static level 30 ft. below land surface. Date July 3

Artesian pressure lbs. per square inch. Date

(12) WELL LOG:

Diameter of well below casing 6"

Depth drilled 124 ft. Depth of completed well 121

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
Boulders & Clay	0	32	
Sand & Gravel Dirty	32	100	30
Sand & Gravel Clean W/B	100	124	30

Work started June 21 1973 Completed July 3 1973

Date well drilling machine moved off of well July 3 1973

Drilling Machine Operator's Certification:

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Robert V. Stoffel (Drilling Machine Operator) Date July 12, 1973

Drilling Machine Operator's License No. 349

Water Well Contractor's Certification:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Name Stoffel Bros. Drilling Co. (Person, firm or corporation) (Type or print)

Address Rt 3 Box 3346 La Grande Ore

[Signed] Robert V. Stoffel (Water Well Contractor)

Contractor's License No. 415 Date July 19, 1973

C.-1

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45656-1

of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

STATE OF OREGON AUG 1976
(Please type or print)
(Do not write above this line) WATER RESOURCES DEPT. SALEM

State Well No.
State Permit No. 2S/43E

(1) OWNER:
Name Pat McLain
Address Lostine Oregon

(2) TYPE OF WORK (check):
New Well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:
Rotary ☐ Driven ☐ Cable ☑ Jetted ☐ Dug ☐ Bored ☐

(4) PROPOSED USE (check):
Domestic ☑ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

CASING INSTALLED: Threaded ☐ Welded ☑
6" Diam. from 0 ft. to 90 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

PERFORATIONS: Perforated? ☑ Yes ☐ No.
Type of perforator used Torch
Size of perforations 1/4 in. by 4 in.
40 perforations from 70 ft. to 90 ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS: Well screen installed? ☐ Yes ☑ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☑ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "
Bailer test 50 gal./min. with 10 ft. drawdown after 1 hrs.
Artesian flow g.p.m.
Temperature of water 49 Depth artesian flow encountered ft.

(9) CONSTRUCTION:
Well seal—Material used Bentonite Slurry
Well sealed from land surface to 20 ft.
Diameter of well bore to bottom of seal 10 in.
Diameter of well bore below seal 6 in.
Number of sacks of cement used in well seal sacks
Number of sacks of bentonite used in well seal 4 sacks
Brand name of bentonite Premium Gel
Number of pounds of bentonite per 100 gallons of water 100 lbs./100 gals.
Was a drive shoe used? ☑ Yes ☐ No Plugs Size: location ft.
Did any strata contain unusable water? ☐ Yes ☑ No
Type of water? depth of strata
Method of sealing strata off
Was well gravel packed? ☐ Yes ☑ No Size of gravel:
Gravel placed from ft. to ft.

(10) LOCATION OF WELL:
County Wallowa Driller's well number
NW¼ NW¼ Section 3 T. 2S R. 43E W.M.
Bearing and distance from section or subdivision corner
NW¼ NW¼ Sec 3

(11) WATER LEVEL: Completed well.
Depth at which water was first found 74
Static level 36 ft. below land surface. Date 8/14
Artesian pressure lbs. per square inch. Date

(12) WELL LOG: Diameter of well below casing
Depth drilled 90 ft. Depth of completed well 90
Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
Rim Rock	0	32	
Boulders	32	56	36
Sand	56	90	36

Work started 8/5 1975 Completed 8/12 1975
Date well drilling machine moved off of well 8/14 1975

Drilling Machine Operator's Certification:
This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.
[Signed] Robert V Stoffel (Drilling Machine Operator) Date 3/15 1976
Drilling Machine Operator's License No. 361

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Name Stoffel Bros Drilling Co (Person, firm or corporation) (Type or print)
Address P.O. Box 361 La Grande Ore
[Signed] Robert V Stoffel (Water Well Contractor)
Contractor's License No. 416 Date 3/15 1976

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45656-1

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

Wall 649

2S/43E-10

(START CARD) # 33600

(1) OWNER: Well Number:
Name Don Hubbard
Address 65714 Getling Rd.
City Enterprise State OR Zip 97828

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

(4) PROPOSED USE:
☐ Domestic ☑ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☐ No ☑ Depth of Completed Well 300 ft.
Explosives used Yes ☐ No ☑ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
12"	0	67	Cement	0	67	30 sacks
8"	67	200				
6"	200	300				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E
☐ Other
Backfill placed from ft. to ft. Material
Gravel placed from ft. to ft. Size of gravel

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	8"	+1	67	.250	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) 67

(7) PERFORATIONS/SCREENS:
☐ Perforations Method
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☑ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
30		300	1 hr.

Temperature of water 50 Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

C-17

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude Longitude
Township 2S N or S. Range 43E E or W.
Section 10 ¼ ¼
Tax Lot 1086 Lot Block Subdivision
Street Address of Well (or nearest address) Lostine, OR

(10) STATIC WATER LEVEL:
79 ft. below land surface. Date 10-
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found 263

From	To	Estimated Flow Rate
263	300	30

(12) WELL LOG: Ground elevation

Material	From	To
Brown clay soil	0	1
Brown clay with large rocks + boulders	1	60
Gray basalt very hard	60	263
Gray basalt, med. hard	263	300

Date started 10-18-91 Completed 10-21-

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alterat abandonment of this well is in compliance with Oregon well const standards. Materials used and information reported above are true to r knowledge and belief.
WWC Number
Signed Date

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction. alteration, or aband work performed on this well during the construction dates reported ab work performed during this time is in compliance with Orego construction standards. This report is true to the best of my knowlec belief.
WWC Number 1
Signed Patrick Wallace Date 11-6-

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER

STATE OF OREGON

WATER RESOURCES DEPT.
SALEM, OREGON

WATER WELL REPORT
(as required by ORS 537.765)

25/7.5E/10

(START CARD) # 16954

(1) OWNER:
Well Number:

Name Lowell D Acmon

Address Box 128

City Lostine State Ore Zip

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☐ Rotary Air ☐ Rotary Mud ☑ Cable

☐ Other

(4) PROPOSED USE:
☑ Domestic ☐ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☐ No ☑ Depth of Completed Well 125 ft.

Explosives used Yes ☐ No ☑ Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10	0	21	Cement Slurry	0	20	7 sacks
6	21	125				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E

☐ Other

Backfill placed from 21 ft. to 20 ft. Material Sand & Gravel

Gravel placed from ft. to ft. Size of gravel

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6	+18	125	.250	☑	☐	☑	☐
Liner:	None							

Final location of shoe(s) 125

(7) PERFORATIONS/SCREENS:
☑ Perforations Method Torch

☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
115	125	1/8 x 4	20			☑	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☑ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
20	8'		2 hr.

Temperature of water 47° Depth Artesian Flow Found

Was a water analysis done? ☐ Yes By whom

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other

Depth of strata:

C-18

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude Longitude

Township 2S N or S. Range 43E E or W.

Section 10 NW ¼ NW ¼

Tax Lot Lot Block Subdivision

Street Address of Well (or nearest address) South Fork Lostine River

(10) STATIC WATER LEVEL:
92 ft. below land surface. Date 10-

Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found 116'

From	To	Estimated Flow Rate
116	123	20

(12) WELL LOG:
Ground elevation

Material	From	To
Rim Rock	0	7
Brown Clay Broken Rock	7	116
Granite Sand w/B	116	123

Date started 10-19-89 Completed 10-23-89

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, altere abandonment of this well is in compliance with Oregon well cons standards. Materials used and information reported above are true to knowledge and belief.

WWC Number

Signed Date

(bonded) Water Well Constructor Certification:

I accept responsibility for the construction, alteration, or aband work performed on this well during the construction dates reported al work performed during this time is in compliance with Oreg construction standards. This report is true to the best of my knowle lief.

WWC Number

Signed Robert V. Steffel Date 10-25-

LOSTINE RIVER TEST WELL
FIELD LOG SUMMARY

FEBRUARY 26,1994

Driller (Bob Stoffel, Stoffel Brothers Drilling) arrives on site with equipment, begins setting up drill rig.

FEBRUARY 28,1994

Driller spends day on rig maintenance, waiting for shipment of parts and drill bit.

MARCH 1,1994

Drill bit and equipment arrive late in day. Driller reassembles equipment, prepares to drill.

MARCH 2,1994

Driller drills 12-inch diameter hole to 10 feet--encounters a large boulder at 10 feet. Conductor casing (1Zinch diameter) set to 10 feet

MARCH 3,194

Driller drills 12-inch diameter hole to 23 feet, damages threads on bit tool joint at midday. Driller removes bit tool and ships to Portland for repair.

MARCH 5,1994

Driller makes up tools and assembles bit configuration for 8-inch diameter drilling. Drilling to 27 feet with 8-inch bit. Preparing to run g-inch casing. Pat Naylor (Montgomery Watson engineer) on site to observe drilling, collect samples.

MARCH 7,1994

Driller welds on 8-inch drive shoe, drills to 50 feet, installs g-inch casing to 40 feet.

MARCH 8,1994

Drill and drive to 60 feet. Difficulty drilling out boulder--encountered at 42 feet, drilled past, then fell into hole, requiring drillout.

MARCH 9,1994

Drill and drive to 100 feet with g-inch boring/casing.

MARCH lo,1994

Drill and drive to 140 feet. Encounter "heaving" conditions starting at 105 feet. Difficult drilling, attempting to clean out and shut off heaving.

MARCH 11,1994

Drill to 160 feet, drive casing to 155 feet. "Heaving" conditions continue to 154 feet. Adding Palmers fluid (a coagulant) to help clean out heaving. More solid conditions encountered below 154 feet. Clean out boring to 160 feet.

MARCH l2,1994

Redrill from 155 to 160 feet. Casing set at 160 feet. Drill to 162 feet. Encounter bedrock at 162 feet. Water level at 105 feet.

MARCH 14,1994

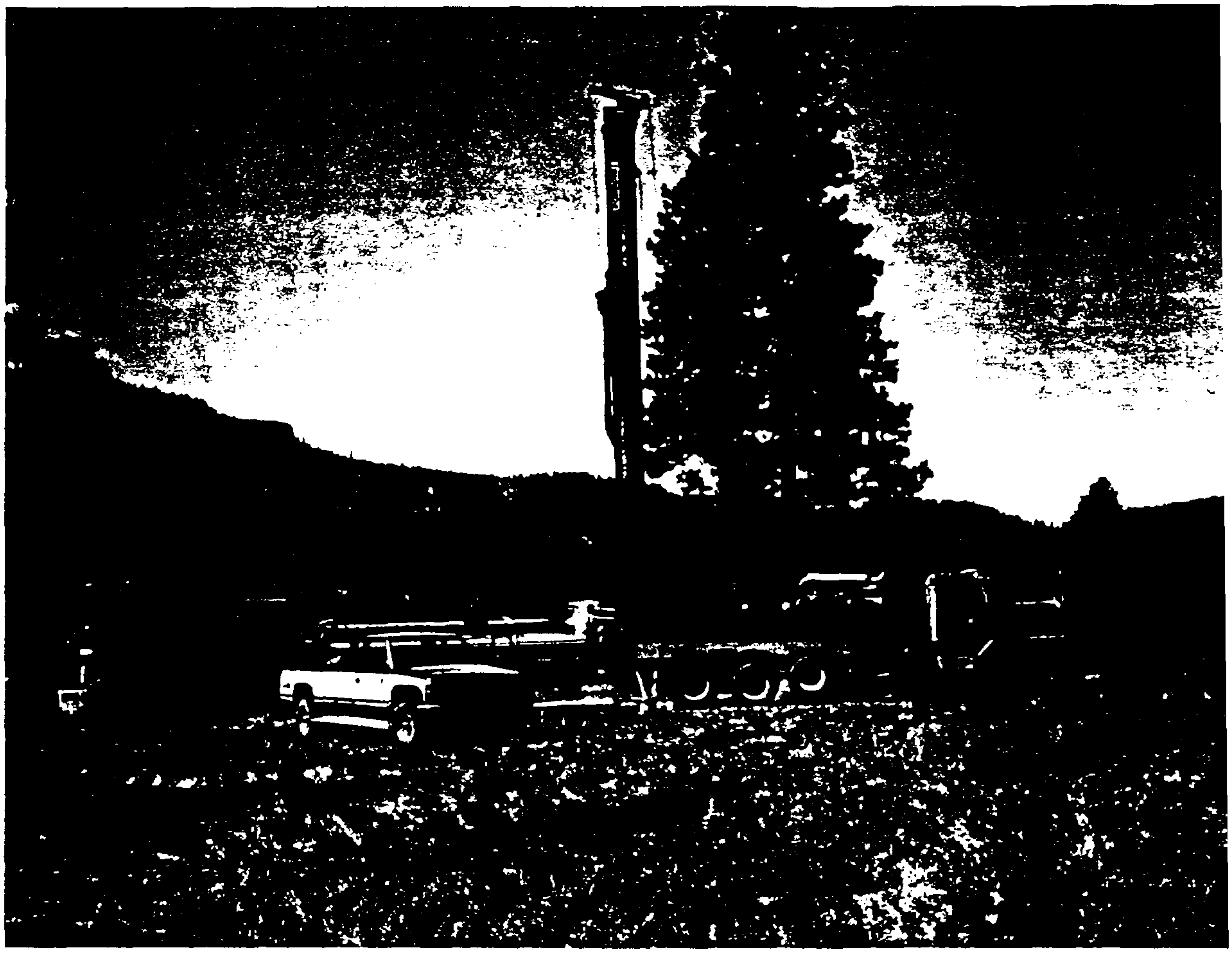
Drill to 172 feet. Drilling in bedrock Pat Naylor on site at midday to collect samples, observe drilling, confinn that bedrock has been encountered. Static water level at 45 feet.

MARCH 16,1994

Clean out well. Test bail for 4 hours. Static water level at 45 feet.

MARCH 17,1994

Demobilize drill rig off site. Clean up area. Weld on solid cap with l-inch access port and plug.



U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife

Preliminary Report of Test Well Drilling Northeast Oregon Hatchery Project

October 1992

JMM James M. Montgomery
Consulting Engineers, Inc.

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SECTION 1

EXECUTIVE SUMMARY

Three test wells were constructed to evaluate the groundwater quality and production potential at three locations in northeast Oregon in an effort to locate suitable water supplies for fish hatcheries. The hatcheries are to be part of the Bonneville Power Administration's Northeast Oregon Hatchery (NEOH) project. Investigations were conducted at locations on the Wayne Marks site on the Imnaha River, the Oregon State University site on Catherine Creek, and at the confluence of the Minam and Wallowa Rivers near the town of Minam. A fourth location, on the Lostine River, south of the town of Lostine, is proposed for later evaluation but is not considered in this report

Two hydrogeologic units are present at each site. The upper hydrogeologic unit is the alluvium which consists of river-deposited clays, silts, sands, gravel, and cobbles. The lower hydrogeologic unit is the Columbia River basalt. The maximum encountered thickness of alluvium is about 60 feet, at the Catherine Creek location. Groundwater from the alluvium was not evaluated because of anticipated low yields compared to the basalt unit. Groundwater from the basalt was evaluated at all three sites to determine potential production yield and acceptability of groundwater quality.

Groundwater quality was determined to be acceptable for fish hatcheries at all three locations. Specifically, H_2S was not found at detectable concentrations at any of the locations, and no groundwater chemistry parameters were determined to be detrimental to fish propagation activities. Groundwater temperature at the Minam site was 70° F and will require chilling for incubation and early rearing uses. Groundwater temperature at Catherine Creek and Minam sites were 50° F and 54° F, respectively, suitable for incubation and early rearing uses with only moderate adjustment.

Groundwater production potential at the Minam location was found to be most favorable, with possible production capacity of 1500 to 2500 gpm long-term yield from a well field of 3 to 4 wells. Production potential at the Imnaha site is limited to about 500 to 1000 gpm from a field of 3 to 4 wells. Groundwater production at the Catherine Creek site is limited in the upper artesian zone to 200 to 400 gpm on a long-term basis. Development of deeper aquifer zones might double the potential yield at Catherine Creek. If consideration is to be given to long-term production at this location in excess of 200 gpm, further study of the deeper aquifer zone is recommended.

SECTION 2

INTRODUCTION

LOCATIONS AND PURPOSE

The purpose of this project was to evaluate the groundwater production potential at four potential hatchery sites as part of final siting for the Northeast Oregon Hatcheries (NEOH) Project The locations were as follows:

- One well on Oregon State Parks Department property at the confluence of the Minam and Wallowa Rivers, just north of the town of Minam (Figure 2-l)

- One well on Oregon State University property on Catherine Creek. about four miles upstream from Catherine Creek State Park (Figure 2-2)

- One well on property owned by Wayne Marks, adjacent to the Imnaha River about five miles south of the town of Imnaha (Figure 2-3)

- One or two wells adjacent to the Lostine River, on property yet to be determined.

Test wells were drilled at each of the first three sites in order to conduct tests to evaluate groundwater production potential, temperature, and quality. Drilling at the fourth site has been deferred for the time being, due to difficulties in negotiating arrangements for a feasible location. This work will be performed at a later date, and a separate report will be prepared for the site investigation results.

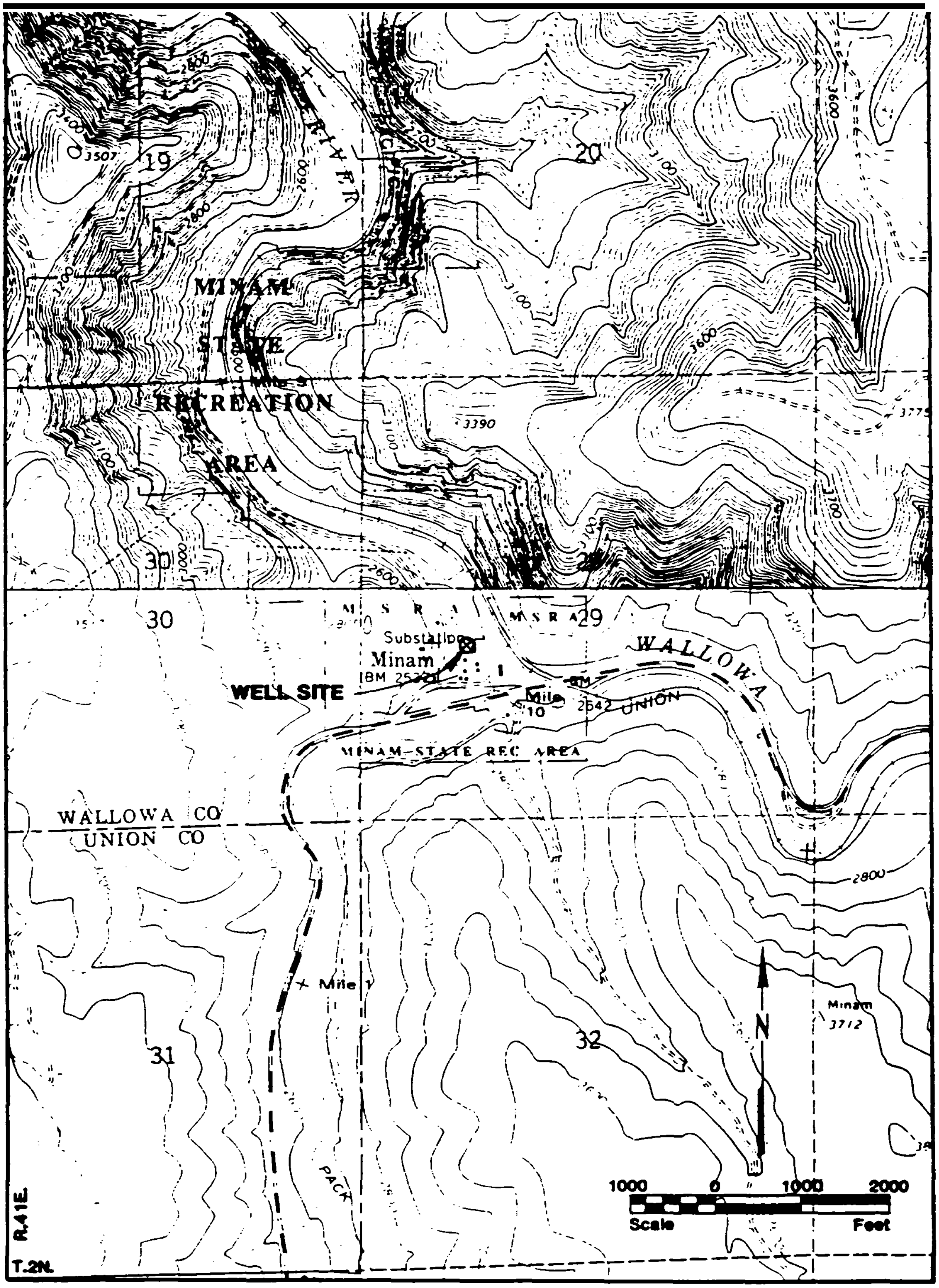
PROJECT SCOPE AND SCHEDULE

The scope of the project consisted of drilling and testing deep wells at the Minam, Imnaha, and (at some future date) Lostine sites, and a shallow well at the Catherine Creek site, in order to evaluate the groundwater characteristics. Care was taken to avoid constructing wells which might interfere with shallow groundwater zones currently in use by domestic wells. Geophysical evaluations were also conducted at the Catherine Creek and Lostine locations to develop a profile of the alluvial thickness.

Following well construction, each well was tested to determine aquifer production potential. During each well test, groundwater temperature, conductivity or TDS, pH, and hydrogen sulfide content were measured in the field, and water samples for laboratory analysis were obtained.

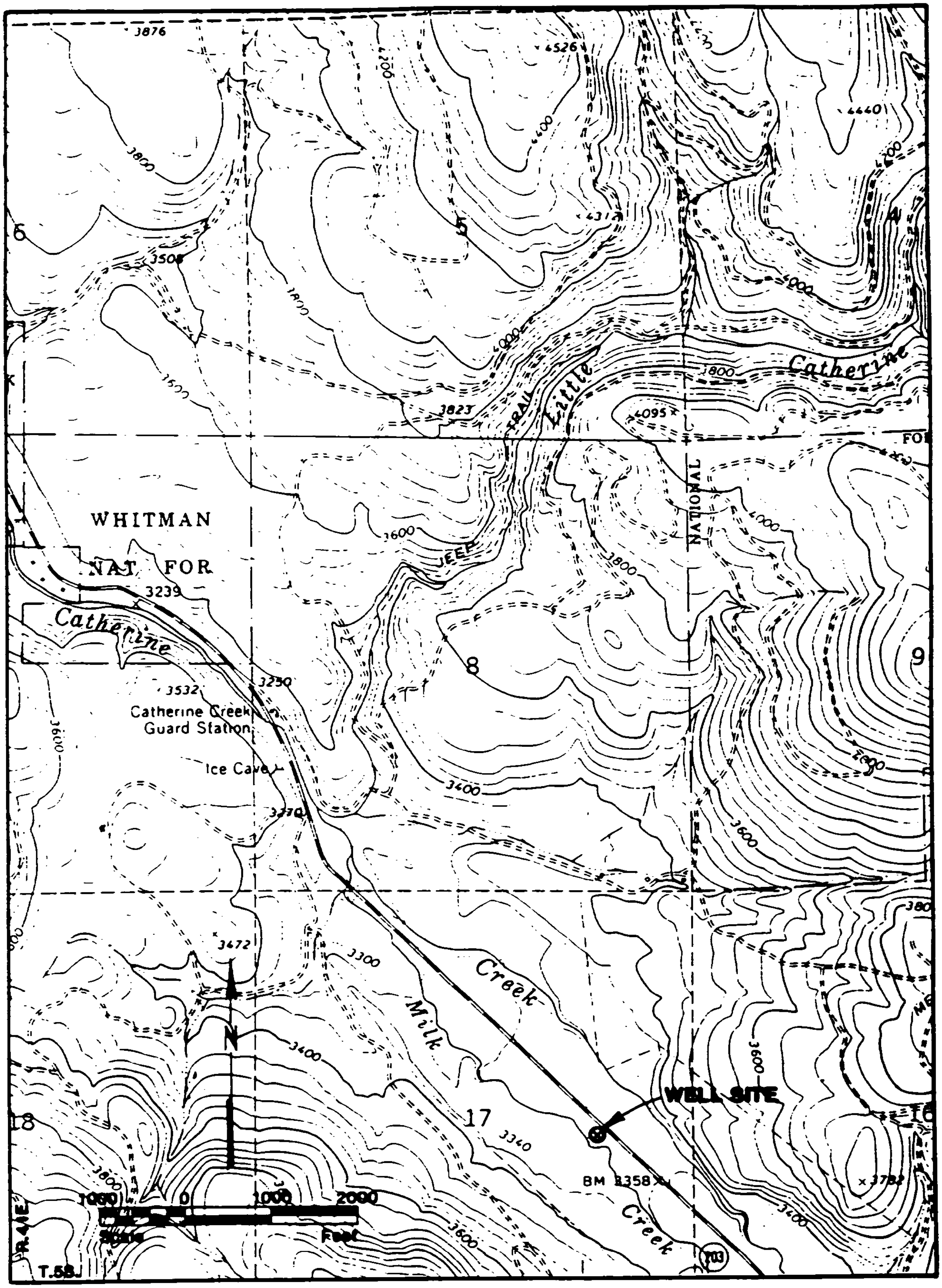
The project was authorized on March 6.1992 by Bonneville Power Administration. Test well sites were staked on March 28. Start of drilling was delayed by difficulties in obtaining cultural clearances. Clearances were obtained in late July. Two drilling contractors were used to drill the wells. Pitcher Pump and Drilling commenced drilling of the **Catherine** Creek well on August 10 and completed the well on August 19. Drilling at the Minam and Imnaha sites was performed by Wallace Drilling. The Minam Well was started on August 11 and was completed on August 19. Drilling at the Imnaha site began on August 20 **and was** completed August 26.

Flow tests of the artesian well at Catherine Creek were performed on September 2 & 3. Pumping tests were conducted at the Minam site from September 8 to September 11. The

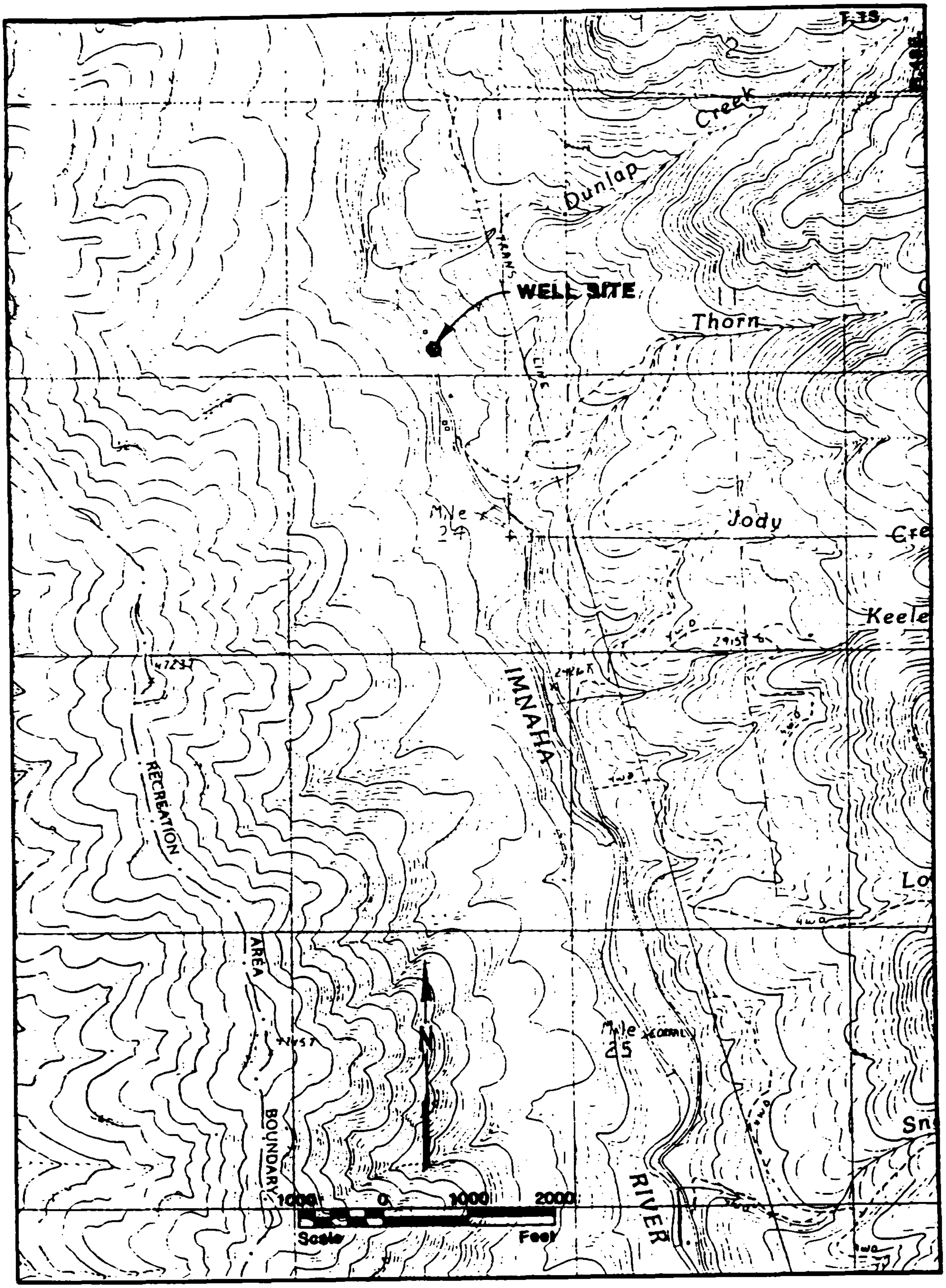


MINAM TEST WELL SfIE

FIGURE 2-I



CATHERINE CREEK TEST WELL SITE
FIGURE 2-2



IMNAHA TEST WELL SITE

FIGURE 2-3

Imnaha well was pump tested from September 14 to September 16. Pump services were provided by Purswell's Pumps Company. JMM supervised the pump test field activities and data analysis. Tests at each location consisted of a preliminary step test, followed by a constant rate test and then recovery monitoring.

HYDROGEOLOGY

Hydrogeologic conditions vary from site to site but in each case at least two basic hydrogeologic units, alluvium and basalt, are found. At the Imnaha site, highly weathered basement rock was encountered below the basalt. No other significant rock types were encountered at any of the locations. Minor cinder beds, encountered chiefly at the Minam site, were grouped together with the basalt hydrogeologic units.

At each location, the basalt consists of the Columbia River Basalt Group. At the Minam and Catherine Creek locations, the basalt encountered corresponds to the Miocene-age Yakima basalt. At Catherine Creek, the andesitic nature of the Yakima basalt tends toward a platy composition; the basalt is more massive at the Minam site. The basalt at the Imnaha site corresponds to the Imnaha basalt of Miocene age.

The upper basement rock underlying the basalt at the Imnaha site consists of an estimated 20 feet of what is probably late Triassic marine sediments. This overlies a weathered granitic rock which could correspond to a Triassic quartz diorite, which regionally underlies the marine sediments. More likely, it may be Cretaceous/Jurassic intrusive quartz diorite stock. The basement rock did not appear to yield significant quantities of groundwater and is not considered a hydrogeologic unit for the purposes of this investigation.

Where suitable, bedrock groundwater sources (in these cases, the basalt aquifer) are preferred to alluvial sources for hatchery groundwater supplies because the water can be economically developed from wells and has constant temperature and quality. Therefore, basalt aquifers were the target of this investigation. The Catherine Creek well, which was originally projected to be an alluvial aquifer well, was extended into the basalt due to the poor groundwater conditions in the alluvium. The Minam and Imnaha wells are deep basalt aquifer wells.

At the Catherine Creek site, the shallow basalt aquifer was found to be a flowing artesian system. Flowing artesian conditions were not encountered at the other locations, although static water levels in each well rose far above the uncased interval. This suggests that confined or semi-confined conditions exist over at least some interval in each of the basalt aquifer well locations.

Quatemary alluvium, the upper hydrogeologic unit, is found from the ground surface to the top of the basalt aquifer. Thicknesses vary from site to site, ranging from about 40 feet at the Minam and Imnaha sites to 60 feet at the Catherine Creek site. 'Ihe water table was first encountered at a depth of about 14 feet at Catherine Creek, at 30 feet at Minam, and at 19 feet at Imnaha. The alluvium consists of sand, gravel, cobbles, and silt. At the Catherine Creek site, a layer of clay constitutes the lower 17 feet of the alluvium and directly overlies the basalt. While contributing little to the alluvial aquifer, this clay layer probably forms a confining layer above the basalt at this site and therefore may be partially responsible for artesian flow from the basalt aquifer.

Where coarse-grained and clean, the alluvium will yield groundwater to wells or infIltration galleries. However, alluvium below the water table at each of the test well sites typically contained significant percentages of fines. Given the narrow width of alluvium along the valley floors and saturated thicknesses of only about 10 to 30 feet (disregarding the low-permeability clay layer at Catherine Creek), groundwater storage is limited in the alluvium. Large production from shallow alluvial well systems would probably involve induced infiltration of river water. As such, the water quality of groundwater derived from the alluvium is probably similar to water quality from the rivers in each drainage. Groundwater temperature in the alluvium is influenced by river water infiltration and can be expected to show considerable seasonal fluctuations.

For a number of reasons, the alluvial aquifers were considered secondary in preference to basalt aquifers as potential water sources. Depending on the permeability and saturated thickness of the alluvium, groundwater can be produced from a variety of shallow well field systems, infiltration galleries, or collector systems. However, infiltration galleries and collector systems can be difficult and costly to construct. Development costs, temperature variability, and water quality can also be problematic. The chief limitation, however, is that shallow alluvial wells are not likely to have the production potential of basalt aquifers.

SECTION 3

TEST WELL SITES

MINAM TEST WELL SITE

Well Construction Narrative

Drilling of the Minam Test Well began on August 11, 1992 and was completed to a total depth of 705 feet on August 19,1992. Well construction involved first drilling with a l2-inch diameter hammer bit through the surface alluvial material to basalt bedrock at a depth of 35 feet and then driving 12-inch temporary surface casing to that depth. A nominal 12-inch borehole was then drilled using a hammer bit to a depth of 142 feet, and an 8-inch diameter casing was driven with a casing hammer to 141.3 feet. A minimum depth of 140 feet was selected for casing based on interviews with local residents, who had indicated that no local wells were deeper than about 100 feet (relative to the elevation of the test well site). No significant water-bearing zones were encountered above 140 feet, so casing to that depth did not significantly reduce potential production from the well. On August 12, the &inch casing was cemented and the 12-inch surface casing was removed.

Drilling was resumed on August 18. An 8-inch open borehole was drilled to total depth. Although the well had been originally projected to be drilled to 600 feet, hydrogeologic conditions suggested that productive fracture zones would continue to be encountered with depth. A decision was therefore made to drill deeper, and the well was eventually completed to 705 feet on August 19. Water producing zones were encountered between the depths of 249 and 260 feet, 288 and 293 feet, 412 and 435 feet, 525 and 545 feet, 565 and 585 feet, and 611 and 653 feet.

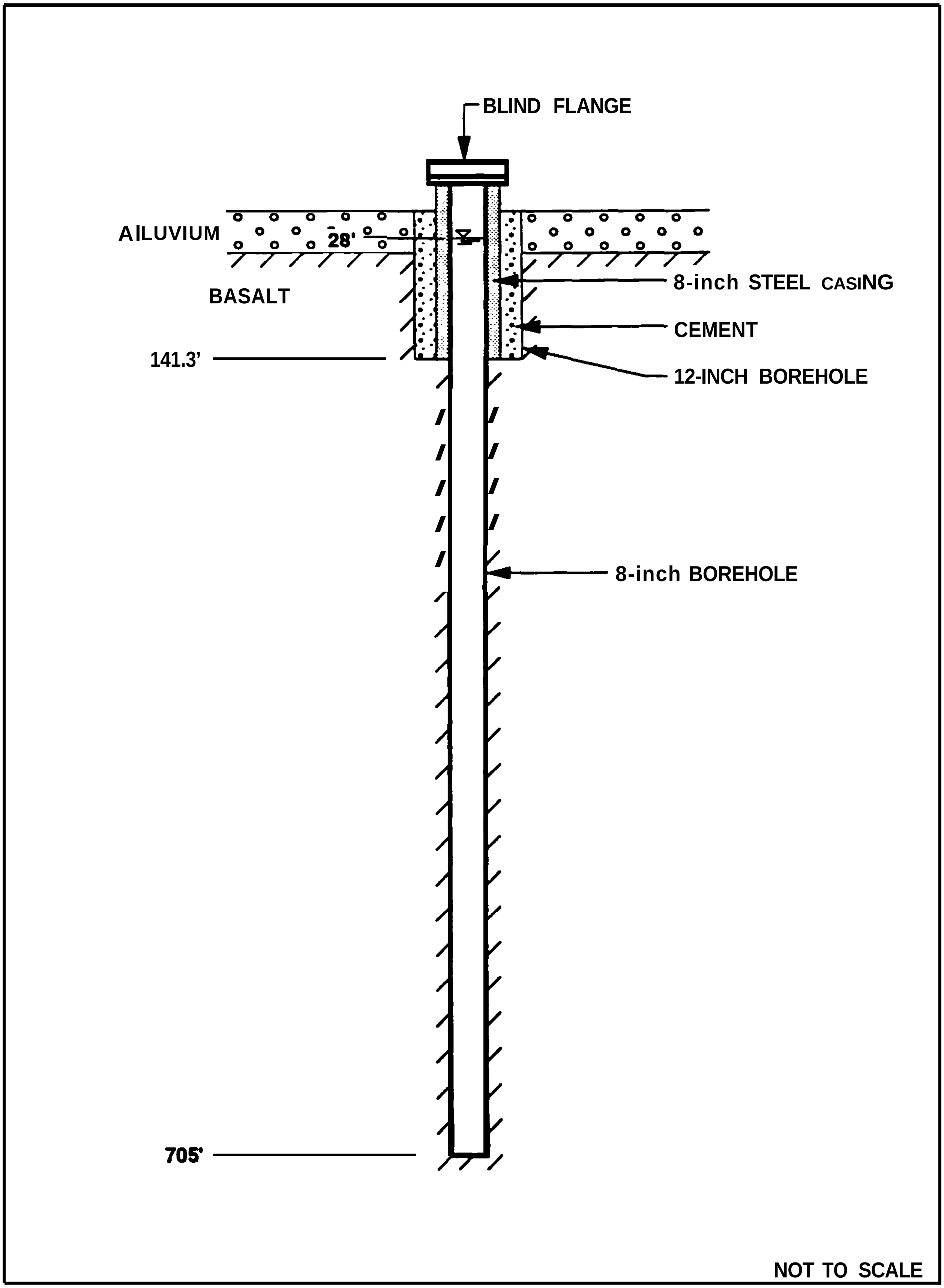
After halting drilling at 705 feet, the well was developed for approximately 2 hours (in addition to periodic development every 25 to 50 feet during drilling). Airlift flow estimates at 705 feet were approximately 700 to 900 gpm. After development, the well was closed with a blind flange. Figure 3-1 is a schematic well construction diagram. A summary field log of well drilling and construction activities is found in Appendix A Summary lithologic logs are found in Appendix B.

Existing domestic wells in the vicinity of the test well site were all screened within the alluvial zone or the shallow upper zone of the basalt aquifer. The Minam test well was cased below the reported depths of the domestic wells in order to ensure that test well pumping did not have an adverse impact

Testing

The Minam Test Well was pump tested on September 8-11. The well was pumped using a 50 horsepower submersible pump set at a depth of 202 feet The discharge line was 4 inches in diameter, and flow was controlled using a Pinch gate valve. Flowrate was monitored using an in-line totalizing flow meter. A l-inch diameter PVC line was installed to about 200 feet for water-level monitoring. Water levels during the tests were monitored using an **Actat™** electric sounder.

A step-rate test was performed on September 8, in order to estimate the specific capacity of the well and to determine the best pumping rate for the constant rate test The well was pumped at 150 gpm, 250 gpm, 350 gpm, and 410 gpm (gate valve completely open) for periods



MINAM TEST WELL
CONSTRUCTION DIAGRAM
FIGURE 3-l

of 30 to 40 minutes. After the step-rate test, the well was allowed to recover overnight to pretest static levels.

A constant-rate pump test was performed on the well on September 9-11. The well was pumped at 400 gpm for approximately 46 hours. Pumping depth to water at the end of the 46-hour test was about 124 feet. Water levels were monitored during the test. After pumping was stopped, water-level recovery was monitored for 8 hours.

Test Well Responcre. Step-rate testing suggested a specific capacity ranging from about 5.9 gpm/fk after 40 minutes at 150 gpm, to about 4.5 gpm/ft after pumping for 30 minutes at 410 gpm. Jacob semi-logarithmic analysis of the constant-drawdown test data indicated a transmissivity (T) of approximately 33,000 gpd/ft. This compares to a T value of 30,000 gpd/ft when analyzed by the Theis log-log method. For recovery data, a transmissivity of about 33,000 gpd/ft was obtained when analyzed by the Jacob semi-log method. No distinctive breaks in slope were noted when the data was plotted, suggesting no significant hydrogeologic boundaries in the vicinity of the well. Pump test data and plots are found in Appendix C.

Water Quality

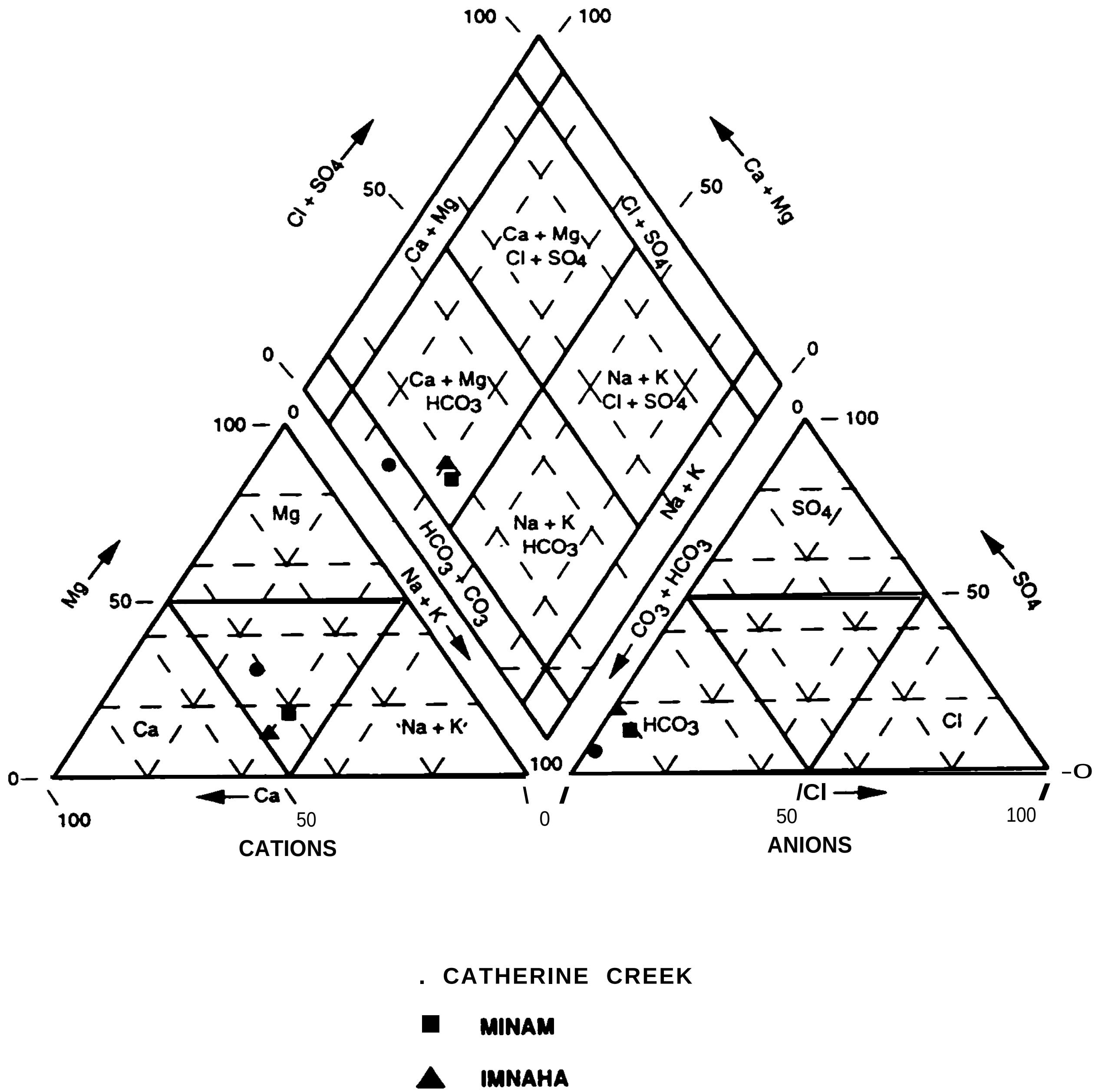
Samples of groundwater were collected after about 24 hours of pumping and again at 46 hours of pumping, just before shutting off the pump. Water samples were submitted to Alchem Laboratories in Boise, Idaho for analysis. Laboratory analytical results are shown in Table 3-l. Laboratory ***reports*** are included in Appendix D.

Average concentrations of the analytical results in mg/L were used to determine ion concentrations in milliequivalents per liter (meqiL). In all cases, average concentrations are very close to the actual ion concentrations. The average concentrations as meq/L were plotted on a trilinear diagram (Figure 3-2) to determine the water type. Using this system, the water from the Minam test well is classified as a calcium-magnesium bicarbonate water.

In addition to laboratory samples, periodic monitoring of pH, conductivity, and temperature were performed, both during drilling and during pump testing. Field testing of H_2S content was also performed during pumping. Field pH monitoring showed an average pH of 7.2. The pH increased steadily from 6.0 early in the constant-rate test to a final pH of 8.0 at the completion of the test. No explanation is apparent for this trend, although monitoring instrument problems due to ambient temperature fluctuations may be responsible. Field measurements of conductivity averaged 231 pS. All field measurements of groundwater temperature during the constant-rate test were **69°** to **70°** F. Field testing for H_2S did not show any detectable concentrations.

Potential Groundwater Yield to Production Wells

The tested interval of the basalt aquifer appears to have good production potential Probable well yields in the range of 500 to 1000 gpm are suggested by test results. A well field of 3 or 4 wells, spaced 500 to 1000 feet apart, should be able to produce in the range of 1500 to 2500 gpm. Aquifer hydraulic parameters calculated from the water-level response during pumping of the test well suggest that each well, if pumped at 500 gpm, would probably cause 25 to 30 feet of “interference” drawdown in another well 500 feet away and 22 feet of interference drawdown in a well at 1000 feet. Three wells in line, spaced 500 feet apart, could anticipate about 170 feet of drawdown in the wells at each end and about 180 feet of drawdown in the ***center well,*** if pumped at 500 ***gpm*** continuously for one year. With a static water level of about 30 feet below ground level, anticipated lifts of approximately 206 feet



TRILINEAR PLOT OF ION CONCENTRATIONS
FIGURE 3-2

and 210 feet are projected for the end wells and center well, respectively, by the end of a one-year period. Pumping levels of approximately 250 feet would result from 3 wells pumping **a** total of 2000 gpm. Intermittent or variable rates of pumping would reduce the extent of drawdown.

TABLE 3-1

TEST WELL ANALYTICAL RESULTS
MINAM TEST WELL

Parameter	Concentrations (mg/L) Mid-Test	Concentrations (mg/L) End of Test
Alkalinity	75.0	77.0
Bicarbonate	75.0	77.0
Carbonate	<l.O	<l.O
Ammonia as N	<0.05	<0.05
Calcium	16.0	16.0
Chloride	2.92	2.80
Conductivity (µS)	175	174
Fluoride	0.34	0.33
Hardness	53.0	53.0
Iron	<0.01	<0.01
Magnesium	3.75	3.75
Manganese	<O.Ol	<O.Ol
Nitrate as N	0.53	0.53
Potassium	4.34	4.27
Sodium	15.3	16.3
Sulfate	8.31	8.10
Sulfide	<0.05	<0.05
Suspended Solids	<1.0	<1.0
pH (SU)	8.00	8.05

Note that these projections are based on results of a single well test. Aquifer conditions will vary with increasing distance from the test well site. However, the test well results suggest that 1500 to 2500 gpm can be developed from a well field at the site. Also, additional **water-**producing zones would be expected at depths below 700 feet. Therefore deeper drilling **may** increase groundwater potential at this site.

CATHERINE CREEK TEST WELL SITE

Geophysical Survey

Prior to drilling at Catherine Creek, a geophysical survey was conducted by means of seismic refraction in order to estimate the depth to, and profile of, the alluvium-bedrock contact. This survey was performed by geophysicist Paul Donaldson at two locations at the OSU site, corresponding to two alternate sites initially considered for well locations. At each site, seismic geophone lines were laid out with an explosive charge at each end. The lines were attached to a seismic recorder. The charges were set off, and the refraction of shock **waves** on the underlying material was registered and recorded using the geophone lines and recorder.

The time necessary for the shock waves to move through the underlying material and refract off the underlying bedrock back to the geophones was calculated. Using available information about the rate of shock wave movement through different types of material, estimates of the depth of alluvium overlying the bedrock were calculated. In this way, profiles of the basalt bedrock beneath the alluvium were obtained, and the thickness of the alluvium was approximated. Estimated depths to bedrock were 58 feet at the upstream site (the eventual test well site) and 50 feet at the downstream site. The calculated alluvial thicknesses are considered to be minimum thicknesses, according to the geophysical report (see Appendix E).

Well Construction Narrative

Construction of the Catherine Creek Test Well began on August 10.1992, and was completed on August 19, 1992. The well was originally planned as an alluvial aquifer test well. However, the alluvial sand and gravel was clayey below about 20 feet. Clay was encountered at about 43 feet, and basalt bedrock was encountered at 60 feet. Airlifting of water in the alluvium during drilling did not suggest that the alluvial zone was very productive. Thus, the alluvial system was disregarded as a significant source of groundwater, and efforts were diverted to exploring the basalt aquifer. Artesian flow of about 200 gpm was first encountered at 73 feet. The well was subsequently drilled to a depth of 170 feet with an 8-inch diameter hammer bit. The well is cased with 8-inch casing, cemented to a depth of approximately 65 feet.

At completion of the well, artesian flow was estimated at 400 gpm. The well was shut in with a blind flange, and a 3-inch side discharge pipe and gate valve were installed. The side discharge pipe was equipped with a pressure gauge. Static shut-in pressure was found to be 10.25 psi. Figure 3-3 is a schematic representation of the well construction. A summary field log of well drilling and construction activities is found in Appendix A Summary lithologic logs are found in Appendix B.

Testing

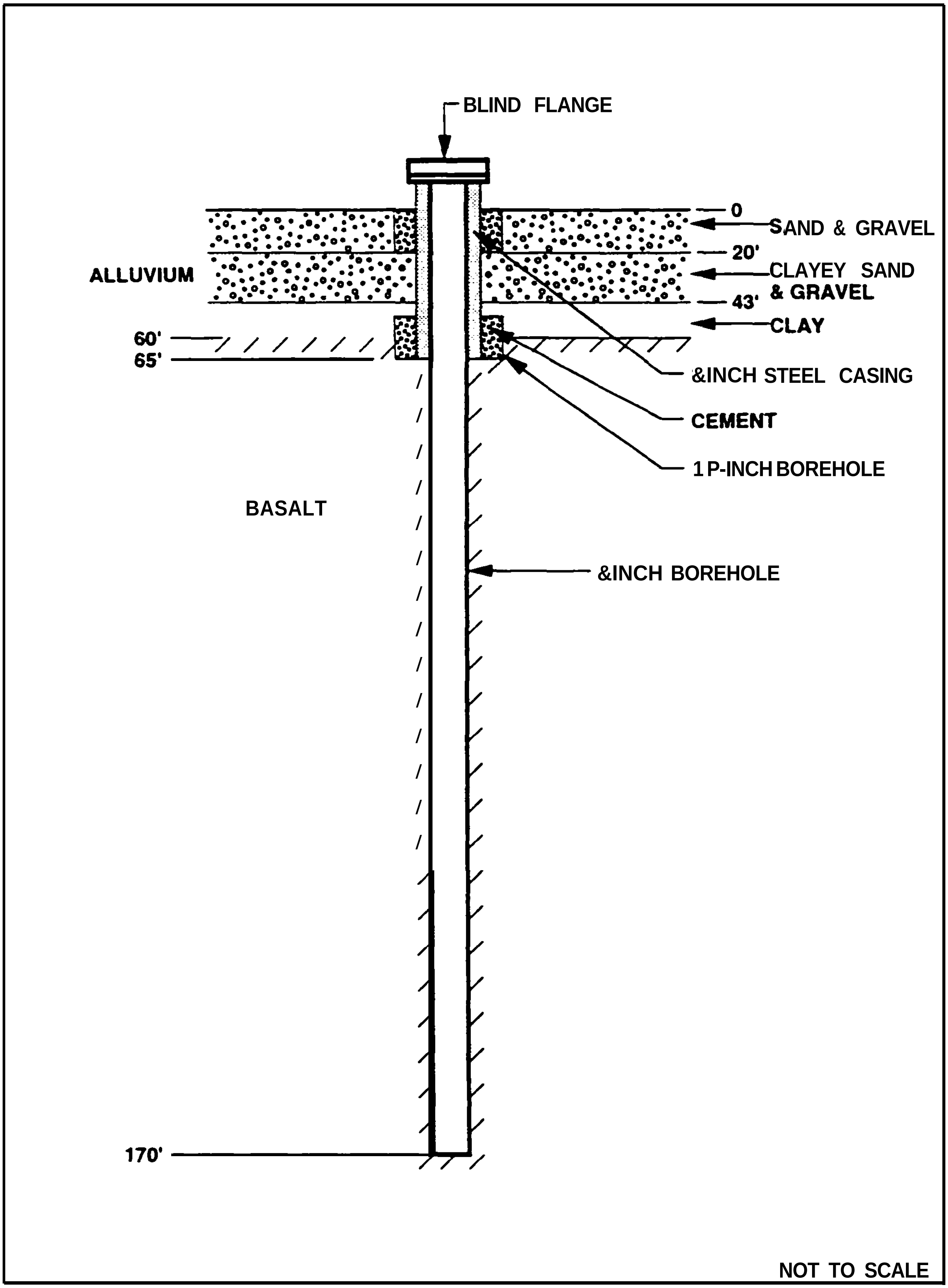
Artesian flow tests were conducted on September 2-4. Flow was regulated with a butterfly valve and measured using a 6x4-inch orifice weir. Artesian pressure was determined using the pressure gauge.

A step-rate flow test was conducted initially on September 2 to estimate specific capacity and optimum test flow rate. Three 30-minute steps were used, with flow rates of 175 and 250 gpm for the first two steps. The third step consisted of opening the valve completely; the resulting flow dropped from an initial rate of 370 gpm to 338 gpm. The valve was then closed, and the well was allowed to recover overnight.

A constant-rate flow test was performed on September 3-4 A flow rate of 275 gpm was used for the flow test. Pressure head was monitored periodically to determine drawdown. Flowrate was monitored and adjusted regularly with the butterfly valve to maintain constant discharge.

After about 6 hours, the valve was completely open. Thereafter, a gradual loss in flowrate was observed. At this point, pressure head declined very slowly, and the test became a constant-drawdown test with variable flow.

After 24 hours, the flow test was terminated. Pressure head recovery was monitored for 3 hours.



CATHERINE CREEK TEST WEU
CONSTRUCTION DIAGRAM
FIGURE 3-3

Test **Well** R.eaponae. The flow test evaluation suggests the existence of hydrogeologic flow boundaries, such as faults, which had an impact on the flow test response. As the radius of influence of the cone of depression increased with time during pumping, the pressure distribution is thought to have encountered these flow boundaries. Boundaries can increase (or decrease) the rate of drawdown. Boundaries appeared to affect flow after about 16 minutes and again at about 100 minutes, suggesting at least two boundaries. As the radius of influence encountered these negative boundaries, drawdown increased. The flow boundaries reduce the calculated, or apparent, transmissivities by as much as an order of magnitude from the initial calculated T to the final calculated T (as determined by the 6-hour constant rate phase of the test). Apparent transmissivities ranged from about 52,000 gpd/ft during the first few minutes of the test to about 6400 gpd/R after about 100 minutes. The net effect of the boundaries is a significant reduction in long-term well yield in comparison to the short-term well yield.

Constant-drawdown evaluation methods applied to the period from about 6 hours to about 24 hours of flow testing indicate an apparent transmissivity of about 2200 gpd/ft. This segment of the test may be less reliable than the constant-rate portion, however, because the test did not commence as a constant-drawdown test

Recovery test data suggested apparent transmissivities of 52,000 gpd/ft for the first 30 minutes of recovery and 13,000 gpd/ft at 30 to 180 minutes of recovery. Flow test and recovery data and plots are found in Appendix C.

Water Quality

Samples of groundwater were collected after about 6 hours of flow testing and again at about 24 hours of flow testing, just before shutting off flow. Water samples were submitted to Alchem Laboratories in Boise, Idaho for analysis. Samples were analyzed for the same parameters as at the Minam site.

Laboratory analytical results are shown in Table 3-2. Laboratory reports are found in Appendix D.

As at the Minam site. average concentrations of the analytical results in mg/L were used to determine ion concentrations in milliequivalents per liter (meq/L). In all cases, average concentrations are very close to the actual ion concentrations. The average concentrations as meq/L were plotted on a trilinear diagram (Figure 3-2) to determine the water type. Using this system, the water from the Miriam test well is classified as a bicarbonate water.

In addition to laboratory samples, periodic monitoring of pH, conductivity, and temperature were performed, both during drilling and during flow testing. Field testing of H_2S content was also performed.

Field pH monitoring showed an average pH of 7.1, although field readings ranged from 5.8 to 8.3. This variability is thought to be due to instrument problems rather than actual change in pH. Conductivity was about 246 **µS** on the average. Groundwater temperature was consistently 50 degrees F for the duration of the flow test. Field testing for H_2S did not show any detectable concentrations.

TABLE 3-2

TEST WELL ANALYTICAL RESULTS
C A - C R E E K

Parameter	Concentrations (mg/L) Mid-Test	Concentrations (mg/L) End of Test
Alkalinity	91.0	**89.0**
Bicarbonate	91.0	**89.0**
Carbonate	<l.O	<1.O
Ammonia as N	<0.05	<O.O5
Calcium	18.0	18.0
Chloride	0.43	0.45
Conductivity (µS)	185	182
Fluoride	0.10	0.10
Hardness	76.0	76.0
Iron	<O.Ol	<0.01
Magnesium	7.75	7.75
Manganese	<0.01	<0.01
Nitrate as N	0.42	0.43
Potassium	2.07	2.05
Sodium	12.5	11.8
Sulfate	4.84	4.79
Sulfide	<0.05	<0.05
Suspended Solids	2.0	4.0
pH (SU)	7.50	7.70

Potential Groundwater Yield to Production Wells

The Catherine Creek well could be expected to produce about 200 gpm for continuous pumping with a pumping level of about 55 feet. Well field development using multiple wells in this area could potentially yield higher flow rates, but spacing between wells would necessarily be large. One or two more wells spaced down the valley could potentially double the production rate from the shallow zone (above 170 feet). However, this test only considered the upper 100 feet or so of the confined basalt aquifer. Greater yields would probably be achievable from deeper within the aquifer. Further drilling and testing is warranted to determine the feasibility of development of the deeper zone of the basalt aquifer at this location.

IMNAHA TEST WELL SITE

***Well Construction* Narrative**

Construction of the Imnaha Test Well began on August 20 and was completed on August 26. Temporary 12-INCH casing **was** driven through the surface alluvium to **a** depth of 38 feet. Basalt was encountered just below this depth, at 41 feet. Groundwater was initially encountered in the alluvium a depth of about 19 feet. A nominal 12-inch boring was drilled below the surface casing to a depth of 105 feet. An 8-inch diameter casing was then installed to a depth of 104 feet. The 8-inch casing was cemented on August 21 and 22. at which time

the 12-inch temporary casing was removed. The cement was allowed to dry over the ensuing weekend, and construction recommenced on August 24. An 8-inch borehole was drilled with a hammer bit to **a** depth of 808 feet.

A highly weathered basement rock was encountered at about 740 feet. below the basalt. The basement rock was difficult to identify initially because of the extreme weathering. It appeared that from 740 feet to about 760 feet, the basement rock was of sedimentary origin, perhaps corresponding to regionally identified marine sediments. Drilling was continued to confirm that the sediments did not constitute an interbed in the basalt. Below about 760 feet, the character of the rock changed but extreme decomposition made identification impossible. At about 800 feet, the weathering had diminished sufficiently to tentatively identify the basement rock as a granitic intrusive rock. Drilling was therefore terminated.

Fractured, apparently productive zones were encountered at 77-79 feet, 162-163 feet, and 380-410 feet. Airlifting from 100 feet produced approximately 150 gpm. Airlifting from 808 feet produced an estimated 350 to 400 gpm. Significant increases in air-lifted flow were not noticeable between about 500 and 808 feet. Development continued after drilling until the discharge was clear. Figure 3-4 is a schematic diagram of the well.

After construction and development, the well was closed with a blind flange. Drilling equipment was demobilized from the site. A summary field log of well drilling and construction activities is found in Appendix A. Summary lithologic logs are found in Appendix B.

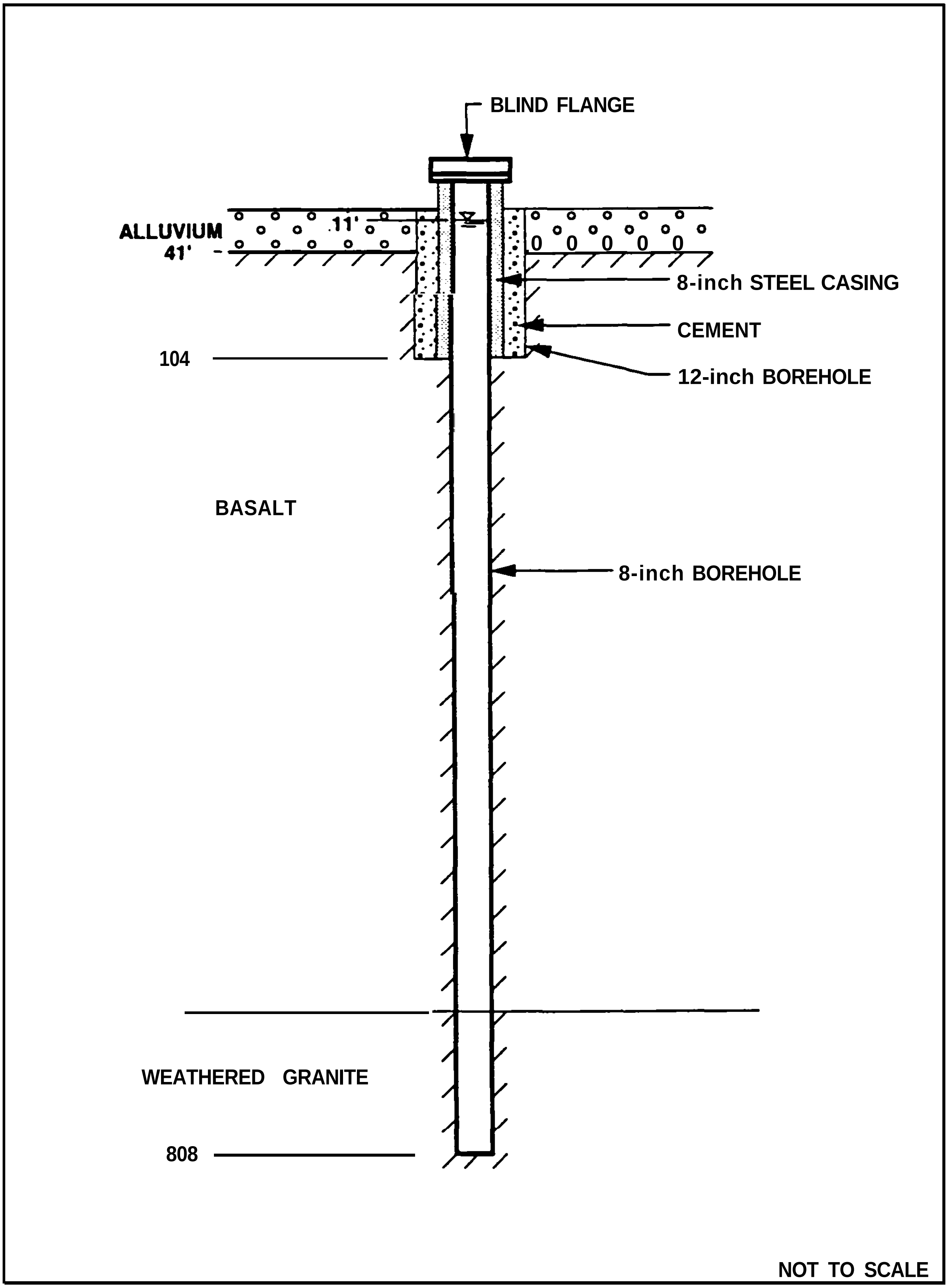
Testing

The Imnaha Test Well **was** pump tested on September 14-16. Test pump equipment and services were provided by Purswell Pump. The well was pumped using a 50 horsepower pump set at a depth of 202 feet. The discharge line was 4 inches in diameter, and flow was controlled using a 4-inch gate valve. Flowrate was monitored using an in-line totalizing flow meter. A l-inch diameter PVC line was installed to about 200 feet for water-level monitoring. Water levels during the tests were monitored using an **Actat™** electric sounder.

A step-rate test was performed on September 14, in order to estimate the specific capacity of the aquifer and to determine the best pumping rate for the constant rate test. The well was pumped at 150 gpm, 250 gpm, 350 gpm, and finally a variable range starting at 390 gpm and dropping to about 340 gpm (with the gate valve completely open) for periods of 30 minutes for each step. After the step-rate test, the well was allowed to recover for about three hours to near-pretest static levels.

Two constant-rate pump tests were performed on the well on September 14 and 15-16. The first test began at 5 p.m. on September 14. The well was pumped at 280 gpm. Originally, a single test was to be conducted for 46 hours. However, at 11 p.m. on September 14 (6 hours into the test), the generator for the pump failed. Repairs on the generator took until the evening of September 15, at which time a second pump test was initiated. The second test ran for 24 hours at a pumping rate of 200 gpm. Water levels were monitored during both tests. Pumping depth to water at the end of the 24-hour test was about 81 feet.. Water level recovery was monitored for 3 hours after pumping stopped for the 24-hour test..

Test **Well** Response. Step-rate testing suggested specific capacities ranging from 4.6 gpm/ft at 150 gpm to about 2.4 gpm/ft at 340 gpm. This suggests that well efficiency is significantly reduced at this location at higher pumping rates.



IMNAHA TEST WELL
CONSTRUCTION DIAGRAM
FIGURE 3-4

Jacob semi-logarithmic analysis indicated a transmissivity of approximately 3300 gpd/ft from data obtained from the first (6-hour) test Data from the second test indicated a possible boundary at about 12 to 15 minutes and again at about 150 to 180 minutes. The initial calculated transmissivity was determined to be 2600 gpd/ft, and the apparent transmissivity between 15 minutes and 180 minutes was calculated to be 4200 gpd/ft. After the second boundary at 180 minutes, drawdown slowed significantly, and an apparent transmissivity of about 18,000 gpd/ft was calculated. This may suggest leakage to the aquifer from the river, alluvium, or shallow basalt aquifer.

Analysis of water level recovery data indicated apparent transmissivities of 1800 gpd/ft for about the first 15 minutes of recovery and 5900 gpd/ft for the recovery period from 15 to 150 minutes. Although not monitored after 180 minutes of recovery, the recovery rate appeared to flatten out, possibly indicating a second boundary as with the constant-rate pump test. Data and response plots are found in Appendix C.

Water Quality

Samples of groundwater were collected after about 15 hours of pumping and again at about 24 hours of pumping, just before shutting off the pump. Water samples were submitted to Alchem Laboratories in Boise, Idaho for analysis. Samples were analyzed for the same parameters as were indicated for the Minam and Catherine Creek locations. Laboratory analytical results are shown in Table 3-3. Laboratory reports are found in Appendix D.

TABLE 3-3

TEST WELL ANALYTICAL RESULTS
IMNAHA

Parameter	Concentrations (mg/L) Mid-Test	Concentrations (mg/L) End of Test
Alkalinity	95.0	97.0
Bicarbonate	95.0	97.0
Carbonate	<1.0	<1.0
Ammonia as N	<0.05	<0.05
Calcium	25.0	25.0
Chloride	0.36	0.40
Conductivity (µS)	228.0	230.0
Fluoride	0.18	0.18
Hardness	78.0	78.0
Iron	0.05	0.01
Magnesium	4.00	3.75
Manganese	<0.01	<0.01
Nitrate as N	0.73	0.74
Potassium	1.85	1.85
Sodium	23.3	21.0
Sulfate	16.5	16.6
Sulfide	<0.05	<0.05
Suspended Solids	1.0	<1.0
pH (SU)	7.55	7.45

Again, average concentrations of the analytical results in mg/L were used to determine ion concentrations in milliequivaients per liter (meq/L). In all cases, average concentrations are very close to the actual ion concentrations. The average concentrations as meq/L were plotted on a trilinear diagram (Figure 3-2) to determine the water type. Using this system, the water from the Imnaha test well is classified as a calcium-magnesium bicarbonate water.

In addition to laboratory samples, periodic monitoring of pH, conductivity, and temperature were performed, both during drilling and during pump testing. Field testing of H_2S content was also performed. Field pH monitoring showed a pH of 8.0, with little variation. Conductivity was about 120 µS on the average, based on adjusted TDS readings. Groundwater temperature was 54 degrees F. Field testing for H_2S did not show any detectable concentrations.

Potential Groundwater Yield to Production Wells

The tested interval of the basalt aquifer appears to have moderate production potential. Potential well yield to an efficient well at this site is about 350 gpm with a 150-foot pumping level.

Based on the results of pumping the single test well, well field development (3 to 4 wells at 500 to lOOO-foot spacings) might result in a total sustainable groundwater supply of 600 to 1000 gpm. No additional groundwater supplies are anticipated at depths below about 800 feet. A potentially productive water zone at 76-79 feet, which is cased in the existing test well, could be tapped by the additional wells, which might increase anticipated flows.

SECTION 4

CONCLUSIONS AND *RECOMMENDATIONS*

CONCLUSIONS

Minam

Of the three locations evaluated, the water supply at the Minam Test Well site was most promising, in terms of quantity. Potential development of 1500 to 2500 gpm, and possibly more, could be obtained at this site with a well field of three to five wells.

Groundwater quality is good to excellent. On the basis of the laboratory analytical results, the water is classified as a calcium-magnesium bicarbonate-type water. No H_2S was detected during field tests. Conductivity averages about 200 pS. The pH measurements during field testing varied between 6 and 8, but appeared to stabilize closer to 8 during the latter part of testing. Laboratory pH was about 8. Water temperature is 69°F to 70°F.

Catherine Creek

The Catherine Creek well could be expected to produce about 200 gpm continuously from a single well. One or two more wells spaced at intervals down the valley could potentially double the production rate from the shallow zone (above 170 feet). Greater yields would probably be achievable from deeper within the aquifer. Further drilling and testing is warranted to determine the feasibility of development of the deeper zone of the basalt aquifer at this location.

Laboratory analyses of groundwater samples indicate that the water quality is very good. Field testing found no detectable H_2S. Trilinear plotting of ionic concentrations indicates that the water is a bicarbonate type. Conductivity was measured between 200 and 300 **µS** in the field and about 185 **µS** in the laboratory. Field measurements of pH at this site are questionable because of equipment problems; laboratory analyses indicate an average pH of 7.6. Water temperature at this location is 50°F.

Imnaha

The tested interval of the basalt aquifer appears to have moderate production potential. Potential well yield to an efficient well at ***this*** site is about 350 gpm with a 150-foot pumping level. Development of a well field with three to four wells might result in a total sustainable groundwater supply of 600 to 1000 gpm.

Water quality appears to be very good at this location. Field testing found no detectable H2S. Ionic concentrations indicate a calcium-magnesium bicarbonate-type water. Field measurements indicate a conductivity of about 120 **µS;** laboratory results were somewhat higher, at about 230 **µS.** In either case, conductivi~ is low. Field measurements of pH wera typically about 8.0. and laboratory pH measurements were about 7.5. Groundwater temperature at the Imnaha site is **54°F.**

RECOMMENDATIONS

Minam

Groundwater supplies at the Minam location could effectively be tapped by development of a well field of three to five wells. The existing test well could serve as the center well. Additional wells upstream and downstream of the test well are recommended at spacings of at least 500 feet. The upstream well(s) could probably be installed on either the Wallowa ***or*** Minam rivers, although site availability and other logistical factors would have to be considered in selection of well sites.

A hatchery at this location could be constructed which would require from 1500 to 2500 gpm on a long-term basis and potentially more for short periods of time. Additional test drilling is warranted at this location to determine the potential for increase in production at greater depths, down to at least 1000 feet, and to confirm well field potential prior to hatchery design.

Catherine Creek

Additional drilling at this site is strongly recommended to test potential groundwater bearing zones below 200 feet This could lx accomplished by either (1) drilling a new well at the downstream site, or (2) cementing B-inch casing to 170 feet in the existing test well and drilling below 170 feet. Deeper drilling should target 600 feet depth, unless site conditions encountered during drilling warrant otherwise.

Imnaha

Additional drilling at this site is also recommended to confirm well field potential. An additional test well should be drilled either upstream or downstream. The well should be drilled to a total depth of 500 feet, unless field conditions warrant otherwise.

MINAM TEST WELL
FIELD LOG SUMMARY

AUGUST 11,1992

Wallace Drilling on site. Drill to -35 feet with 12-inch bit, set surface conductor casing at that depth. Drill to 142 ft, drive 8-inch casing to 141.3 ft. Trip out bit and pipe to fix head gear box problem (will take several days to repair). Pat Naylor (PNN) of JMM interviews local residents to obtain general information about local wells. Four wells identified. Store well is -50 feet deep. Hotel well depth unknown but less than 100 feet. House well 100-120 feet deep. Schoolhouse well depth unknown but probably <120 feet deep (this well is 40-50 feet higher in elevation than test well). Brian Mayer, Dept. of Water Resources, visits site in late pm.

AUGUST 12,1992

Run tremie pipe, cement 8-inch casing. Pull 12-inch temporary casing. Continue repairs on head gear box.

AUGUST 18.1992

Drill from 141 ft to 510 ft. PNN logs cuttings. periodically measuring and recording temperature, pH. EC, ORP. @ 483 ft (last measurement of day), airlifting -200 gpm. temp. = 68 degrees F, pH = 7.99, EC = 260 µS.

AUGUST 19,1992

Prior to resuming drilling, static water level = 25 ft below top of casing. Drill 510 ft to 705 ft. Monitor airlift, temperature, pH, EC, ORP periodically. At 705 ft. airlifting 700 to 900 gpm, temp. = 72 degrees F, pH = 7.68, EC = 198 µS. Stop drilling at 705 ft (TD), develop well for - 2 hours (note well also developed periodically at various depths during drilling). Discharge clear during, after development. Drillers trip out of well, demobilize most equipment to Enterprise for drilling @ Imnaha site.

SEPTEMBER 8.1992

PNN, Purswell Pump at site. Purswell has installed pump at 202 ft to pump well and equipped discharge pipe with a gate valve and totalizing flow meter. Perform step-rate pump test to determine specific capacities at different rates and establish pumping rate for constant-discharge test. Pump four steps for durations of 30 to 40 minutes each at rates of 150 gpm, 250 gpm, 340-345 gpm, and 410 gpm (wide open). Monitor flow rate, back pressure, and depth to water periodically during each step. Shut off flow, monitor partial recovery to evaluate how quickly well will return to pretest levels. Elect to allow overnight recovery.

SEPTEMBER 9,1992

Begin constantdischarge test. Pump well at 400 gpm while monitoring drawdown and flowrate. Periodically monitor pH, conductivity, temperature. Analyze for H_2S.

SEPTEMBER 10,1992

Continue constant-discharge test at 400 gpm, monitoring periodically for pH, conductivity, and temperature. Analyze for H_2S. Collect ground water samples after 24 hours of pumping. Store ground water samples in ice chest.

SEPTEMBER 11,1992

Continue constant-discharge test until 46 hours of duration. Collect ground water samples, monitor for pH, conductivity, temperature, and H_2S. Shut off pump. Monitor recovery for 8 hours. Remove pump after about 2.5 hours. Purswell leaves site to set up at Imnaha. PNN leaves site with samples for Boise.

CATHERINE CREEK TEST WELL
FIELD LOG SUMMARY

AUGUST 10.1992

Pat Naylor (PNN) of JMM, Pitcher Drilling at site. Drill to 20 ft. with 8-inch hammer bit. Encounter water -14 ft bgl. At 20 feet, change to 12-inch tricone bit. Attempt to ***ream out*** hole with larger bit but encounter difficulty drilling, keeping hole open in cobbles. Driller attempts to drill open hole in gravels without success, then attempts to drill using 14-inch temporary conductor casing with little success.

AUGUST 11-12.1992

Attempt to drive 12-inch casing but encounter problems. Little progress made.

AUGUST 13.1992

Drill, drive 12-inch casing to -18 feet, but casing, hole is not plumb. Redrill, redrive 12-inch casing, set @ 18 ft. With much difficulty, drill and drive 8-inch casing with hammer bit to-22 ft. Drill to 40 ft with 8-inch hammer bit, but unable to hold hole open.

AUGUST 14.1992

Drill, drive 8-inch casing to -37 ft. Drill out in front of 8-inch casing with 6-inch hammer bit to 75 feet. Encounter **basalt** bedrock @ 65 feet. Encounter artesian groundwater 8 73 feet. Flowing -200 gpm, temperature = 50 **degrees** F, pH = 7.58, EC = 381 **µS.** No odor, slight mineral taste.

AUGUST 15-17,1992

Set plug at 65 feet. Advance casing to 55 feet. Underream casing from approximately 55 to 65 feet. Set and cement casing to 65 feet.

AUGUST 19.1992

Drill out plug and drill to 170 feet. Cap well with blind flange.

SEPTEMBER 1,1992

PNN at site. Open blind flange, attach butterfly valve and 6-inch by 6-foot discharge pipe with It-inch orifice and manometer. Perform step-rated flow test for three steps of 30 minutes each. The first step is at 175 g-pm, the second is at 250 gpm. and the third is wide open (ranging From 370 to 338 gpm). Monitor drawdown during each step to estimate rate for constant-discharge test and determine specific capacities. Close valve to allow complete recovery overnight

SEPTEMBER 2,1992

Start constant-discharge flow test at 275 gpm. Discharge adjusted periodically for about 6 hours until valve is wide open. At this point, test is converted to constant-drawdown test with variable (falling) flowrate. Collect groundwater samples after about 6 hours of pumping. Pressure head and discharge monitored periodically for duration of test. Conductivity, pH, and temperature monitored occasionally. Sample, analyze for **H_2S.**

SEPTEMBER 3,1992

Continue monitoring constant-drawdown test until test has run about 24 hours. Collect groundwater samples and monitor pH, conductivity, and temperature. Analyze for H_2S. Shut off flow, monitor pressure head recovery for 3 hours. Disassemble orifice equipment, replace blind flange, return to Boise with equipment and samples.

IMNAHA TEST WELL
FIELD LOG SUMMARY

AUGUST 20,1992

Mobilize drilling equipment to Imnaha site from Minam site. Begin drilling for 12-inch surface casing by 1330. Drive 12-inch surface casing to 36 ft.

AUGUST 21.1992

Drill out 12-inch surface casing, determine that surface casing has not been driven to bedrock. Add casing, drive to -38 ft. Drill out, change to l2-inch hammer bit. Drill out casing, encounter bedrock @41-42 ft. Drill with 12-inch bit to -105 ft. Set 8-inch casing in hole to 104 ft. Cement 8-inch casing, pull 12-inch casing.

AUGUST 22,1992

Complete cementing 8-inch casing to surface.

AUGUST 24.1992

Weld flange on 8-inch casing. Drill open-hole with 8-inch hammer bit to 308 ft. Water temperature = 56 degrees F.

AUGUST 25,1992

Drill 8-inch open hole from 308 ft to 608 ft. Water temperature = 54 to 56 degrees F. Airlifting est. 250 to 350 gpm.

AUGUST 26.1992

Measure static water level @ 12.17 ft. below top of casing (10.2 ft below ground level). Drill 8-inch open hole from 608 ft to 808 ft (total depthi. Encounter basement rock below 740 ft. Extremely weathered at contact with basalt-could not positively identify until below 800 ft. Develop well until discharge is clear (about 2 hours, plus drilling airlifting development).

AUGUST 27.1992

Demobilize drilling equipment from site.

SEPTEMBER 11.1992

Purswell Pump on site, set up pump in well. Pump set at 202 feet with 4-inch discharge pipe, gate valve, and in-line totalizing flow meter.

SEPTEMBER 14,1992

Perform step-rate pump test. Pump at rates of 150 gpm, 250 gpm, 350 gpm, and a variable rate (390 to 340 gpm, with valve wide open) for steps of 30 minutes each to evaluate best constant-discharge pumping rate and determine specific capacities. Monitor water level drawdown and flowrate during steps. Stop pump and allow water level recovery. Begin constant-discharge test when *recovery* is near to pre-test static level. Pump well at 280 gpm, monitoring water level and flow rate periodically. Adjust flow rate as necessary to maintain constant discharge. Monitor pH. conductivity, temperature. After pumping at 280 gpm for six hours, generator fails, terminating test.

SEPTEMBER 15,1992

Generator repaired by late afternoon. Resume second constant-discharge test at 1740. Pump well at 200 gpm, monitoring drawdown and discharge rate. Occasionally monitor pH, conductivity, temperature, and H_2S.

SEPTEMBER 16,1992

Continue constant-discharge test until duration of 24 hours for second test. Periodically monitor water level, flowrate, pH, conductivity, temperature, and H_2S concentration. Collect ground water samples after 15 hours and 24 hours of pumping. Stop pumping at 24 hours. Monitor water level recovery for 3 hours.

SEPTEMBER 17.1992

Purswell pulls pump, closes well, demobilizes from site.

SUMMARY WELL LOG
MINAM TEST WELL

Depth (ft)	Description
o-1	Silt - Light gray, soft, -5 percent fine sand, -95 percent low plasticity silt, dry, ML. Topsoil.
l-6	Gravel and Cobbles - Dark gray, -90 percent broken gravel (-80 percent basalt, -20 percent quartz and feldspars), -10 percent fines, loose, GW. Fluvial deposits.
6-29	Cobbles and Boulders - Black, 100 percent broken cobbles and boulders (90 percent basalt, 10 percent quartz and feldspars), loose, GP. Fluvial deposits.
29-40	Silty Gravel - Red, brown, and black, 70-80 percent gravel, 20-30 percent fines. wet, GM. Fluvial deposits. Encountered groundwater -29 ft.
40-80	Basalt - Very dark gray to black, soft to moderately hard, moderately weathered to weathered.
50-94	Basalt - Red and black, moderately hard, moderately weathered, -25 percent very soft soapstone precipitate.
94-115	Basalt - Black, moderately hard, little to moderate weathering, no precipitates. Thin fracture zone at -95 feet.
115-135	Basalt - Black, moderately hard, little weathering, <5-20 percent soapstone precipitate (less abundant with depth).
135-141	Basalt - Gray, little weathering, no precipitate.
141-155	Basalt - Black, moderately soft to soft, moderately weathered, trace soapstone.
155-158	Basalt - Very dark brown, soft, well weathered, lo-15 percent soapstone.
158-165	Basalt - Very dusky red, soft, trace soapstone.
165-168	Basalt - Very dark gray, no weathering, no soapstone.
168-176	Basalt - Black, well weathered, 10 percent soapstone.
176-183	Basalt - Very dark gray, moderately weathered, trace soapstone.
183-190	Basalt - Black, broken, weathered, abundant soapstone. Large, partially weatered clasts (2-3 inches diameter) with precipitate on surfaces.
190-224	Basalt - Very dark gray, soft, well weathered, broken, trace to 20 percent soapstone.
224-233	Basalt - Black, soft, well weathered, trace to 20 percent soapstone.

233-249	Basalt - Very dark gray, hard, very little weathering.
249-270	Basalt - Dark red to reddish brown, soft to moderately hard, moderately weathered to weathered, trace to 5 percent soapstone. @ 255 ft. airlifting 75-100 gpm. @ 260 ft, airlifting >150 gpm. Temp. = 65 degrees F, pH <6 (drifting), EC = 200 µS.
270-282	Basalt - Very dark gray to very dark brown, hard, little to moderate weathering, no precipitate. Airlifting -75 gpm.
282-285	Basalt - Black and brown, broken, trace soapstone.
285-288	Basalt - Very dark gray, weathered, no soapstone.
288-293	Basalt - Red and black, soft, <5 percent soapstone. Airlifting – 100 gpm.
293-324	Basalt - Black, soft, moderately weathered, 10-30 percent soapstone (increasing with depth).
324-329	Basalt - Dark reddish brown, soft, weathered, 15 percent soapstone (typically on faces of basalt fragments).
329-333	Basalt - Black, soft, weathered, no precipitate. Temp. = 66 degrees F, pH = 7.42, EC = 219 µS.
333-340	Basalt - Dark reddish brown, soft, weathered, 15 percent soapstone (typically on faces of basalt fragments). @ 333 ft, airlifting 100-125 gpm.
340-350	Basalt - Reddish black, soft, little to no weathering (increasing with depth), trace soapstone. Airlifting -150 gpm.
350-387	Basalt - Black (increasingly more gray with depth), hard, little weathering. @ 360 ft. airlifting 150-200 gpm. @ 380 ft, airlifting 150-200 gpm, temp. = 65 degrees F, pH = 7.70, EC = 200 µS.
387-390	Basalt - Black, moderately hard, very little weathering.
390-4 10	Basalt - Very dark grayish brown, hard, well weathered, trace to no soapstone.
410412	Basalt - Black, moderately hard, little weathering, trace soapstone. Airlifting -200 gpm, temp. = 66 degrees F, pH = 7.82, EC = 895 µS, ORP = 83 ppm.
412-436	Cinders - Red to reddish brown and black, very soft, friable, 5-10 percent soapstone. Airlifting >200 gpm.
436-450	Basalt - Red, brown, and black, soft, weathered, friable, 5 percent soapstone.
450-454	Basalt (or Cinders?) - Very dusky red, soft, weathered, friable, <5 percent soapstone. Not as soft as cinders @ 412 ft - probably basalt.
454-459	Basalt - Very dark brown, moderately hard, moderately weathered, trace soapstone. Airlifting 200 gpm.

459-483	Basalt - Black, moderately hard to hard. moderately weathered, 0 to 10 percent soapstone (disappearing with depth). @ 460 ft. temp. = 69 degrees F, pH = 7.69, EC = 394 μS, ORP = 129 ppm. @ 480 ft. airlifting -200 gpm, temp. = 68 degrees F, pH =7.99, EC = 260 μS, ORP = 156 ppm.
483-525	Basalt - Very dark brown, hard, moderate weathering.
525-545	Basalt - Black and red to very dusky red, soft, weathered (less weathered with depth), trace to 10 percent soapstone. @ 530 ft, airlifting 400 gpm. @ 540 ft. temp. = 71 degrees F, pH = 7.05, EC = 206 μS, ORP = 168 ppm.
545-552	Basalt - Dark reddish brown, hard, little weathering.
552-564	Basalt - Very dusky red, moderately soft, possibly moderately weathered, <5 percent soapstone (large fragments).
564-580	Basalt - Red and black, soft, moderately weathered, 5 to 10 percent soapstone.
580-586	Basalt - Dark reddish brown, soft. weathered, 10 percent soapstone. Gradually darker, harder with depth. Airlifting 450-500 gpm.
586-598	Basalt - Black, moderately hard to hard, little to no weathering, trace to no soapstone.
598-599	Basalt - Dark reddish brown, soft, well weathered.
599-611	Basalt - Black, hard, little to moderate weathering, trace to no soapstone. @ 605 ft. airlifting 500 to 600 gpm. temp. = 71 degrees F, pH = 7.29, EC = 433 μS, ORP = 174 ppm.
611-617	Basalt - Very dary gray, soft, weathered.
617-639	Basalt - Dark reddish brown, soft, weathered, 5 percent soapstone.
639-653	Basalt - Red and black, very soft, moderately weathered, -15 percent soapstone.
653-705	Basalt - Black, hard, little to moderate weathering, trace to 10 percent soapstone. Weathering increases gradually with depth. @ 655 ft. airlifting 600-700 gpm. temp. = 71 degrees F, pH = 7.48, EC = 339 μS, ORP = 189 ppm. @ 705 ft. airlifting 700-900 gpm. temp. = 72 degrees F, pH = 7.68, EC = 198 μS, ORP = 258 ppm.

SUMMARY WELL LOG
CATHERINE CREEK TEST WELL

DEPTH (FT)	DESCRIPTION
0-1	Topsoil.
1-20	Gravel - loose, well rounded, poorly graded, GP. Fluvial deposits. Water table encountered – 14 ft.
20-30	Clayey Gravel - Dark grayish brown, loose, -75 percent rounded gravel, -25 percent fines, GM. Gravel -80 percent basalt with -20 percent of gravel possible sandstone. Fluvial deposits.
30-43	Clayey Gravelly Sand - Very dark grayish brown, loose, 25 percent subrounded gravel, 50 percent coarse subrounded sand, 25 percent fines, SM. Fluvial deposits.
43-49	Sandy Gravelly Clay - Dark brown, loose, 20 percent subrounded gravel, 20 percent coarse sand, 60 percent moderately low plasticity clay, soft, CL. Alluvium.
49-59	Clay - Reddish brown, plastic, soft, CH. Alluvium.
59-60	Clayey Sand - Brown, loose, 10 percent gravel, 50 percent angular sand (may be ground-up gravel), 40 percent fines, poorly graded, SM. Alluvium.
60-170	Basalt - Dark gray, rubbly (weathered). Encountered artesian flow @ 73 ft. Flowing 150-200 gpm at 75 ft. Temp. = 50 degrees F, pH = 7.58, EC = 381 µS. No odor, sl. iron taste. After -3.5 hours, temp. = 50 degrees F, pH = 8.25, EC <200 µS (drifting), ORP = 49 ppm.

SUMMARY WELL LOG
IMNAHA TEST WELL

Depth (ft)	Description
O-l	Topsoil.
l-30	Clayey Gravel, GM, -25 percent clay, -75 percent poorly graded, rounded to subrounded gravel. River-deposited alluvium.
30-41	Gravel, GP, 100 percent poorly graded. rounded gravel. River-deposited alluvium. Airlifting est. 30 to 40 gpm.
4 l-76	Basalt, black, moderately to very weathered, moderately hard. Airlifting est. - 10 gpm.
76-79	Clayey Gravel, GM, very dark grayish brown, -20 percent clay, alluvium. Airlifting est. 100 to 150 gpm.
79-123	Basalt. black, moderately to very weathered, moderately hard, zones of "soapstone" and other precipitate (calcite?), typically 5 to 10 percent when present. Airlifting est. 150 to 200 gpm.
123-321	Basalt, very dark gray, moderately to extremely weathered. soft to hard (typically softer in more weathered zones), typically -5 percent soapstone and other precipitate. Highly oxidized zone at 162 to 163 feet and at 179 to 180 feet. Phenocrysts occur frequently. Airlifting est. 200 gpm throughout most of zone. @ 215 ft. temp. = 56 degrees F, pH = 7.74, EC = 555 µS, ORP = 50 ppm. @ 310 ft, temp. = 54 degrees F, pH = 7.84, EC = 328 µS, ORP = 102 ppm
321-341	Basalt, black, increasing weathering with depth, moderately hard, 5 to 10 percent soapstone precipitate.
341-419	Basalt, very dark gray, moderately hard, moderately weathered to weathered, zones of precipitates, most abundant (10 to 20 percent) from 361 to 370 ft. Airlifting est. 250 to 300 gpm @355 ft. increasing to est. 300-350 gpm between 380 and 410 ft. @ 410 ft, temp. = 56 degrees F, pH = 8.19, EC = 307 µS, ORP = 106 ppm.
419470	Basalt, black, soft to hard, modereately weathered, soapstone and other precipitates present in some zones (typically 5 to 10 percent when present).
470-5 18	Basalt, very dark gray, soft, weathered, -5 percent soapstone precipitate. Airlifting est 300-350 gpm, temp. = 56 degrees F, pH = 8.35, EC = 324 µS, ORP = 107 ppm.
5 18-560	Basalt, black, soft, weathered, soapstone and other precipitates present in varying percentages from trace to about 20 percent between 528 and 530 feet.
560-565	Basalt, black, hard, weathered, 10 percent precipitates. Airlifting est. 350 gpm, temp. = 56 degrees F, pH = 8.58, EC = 274 µS, ORP = -108 ppm (drifting).

565-623	Basalt, very dark gray, moderately weathered to weathered, soft to moderately soft, typically less than 5 percent soapstone precipitates. @ 615 ft, calculate airlift flow to be -325 gpm using crude weir. At 620 ft, temp. = 55 degrees F. pH = 8.47, EC = 264 µS, ORP = 156 ppm.
623-710	Basalt, black, little to moderately weathered (well-weathered from 684 to 690 ft). hard, typically less than 5 percent precipitates. Airlifting typically 325 to 350 gpm. as calculated by weir. Airlifting increasing to -400 gpm @ 408 ft. @ 690 ft. temp. = 56 degrees F, pH = 8.53, EC = 259 µS, ORP = 120 ppm.
710-720	Basalt, black and brown, hard, very weathered @ 712 ft. less weathered by 720 ft. -5 percent precipitates.
720-740	Basalt, very dark gray, moderately soft to moderately hard, moderately weathered, trace soapstone precipitate. Airlifting 300 to 400 gpm.
740-748	Basement rock, dark gray, very soft, extremely weathered, nature uncertain but possibly highly weathered.marine sediments (mudstone?). Temp. = 57 degrees F, pH = 8.84, EC = 308 µS, ORP = 93 ppm.
748-758	Basement rock (mudstone?), reddish brown and light gray, very soft, extremely weathered.
758-808	Granite or Quartz Diorite, light greenish gray to light gray and red (more light gray with depth), soft (increasingly harder with depth), extremely weathered (reduced weathering with depth). a few highly weathered mica crystals visible below -800 ft. Airlifting 350 to 400 gpm (no appreciable change from basalt). temp. = 56 degrees F, pH = 8.76, EC = 250 µS, ORP = 137 ppm. Stop drilling @ 808 ft when rock clearly identifiable as granitic.

STATE OF OREGON
WATER WELL REPORT
as required by ORS 537.765l

(START CARD) # 41992 (Pg.1

(1) OWNER: Well Number
Name U.S. Dept. of Energy, Bonneville Power
Address P.O. Box 3621
City Portland State OR Zip 97208

(2) TYPE OF WORK:
[X] New Well [ ] Deepen [ ] Recondition [ ] Abandon

(3) DRILL METHOD:
[X] Rotary Air [ ] Rotary Mud [ ] Cable
[ ] Other

(4) PROPOSED USE:
[ ] Domestic [ ] Community [ ] Industrial [ ] Irrigation
[ ] Thermal [ ] Injection [X] Other Exploratory

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes [X] No Depth of Completed Well 705 ft.
Explosives used Yes Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
12"	0	141	Cement	0	141	69 sacks
8"	141	705				

How was seal placed: Method [ ] A [ ] B [X] C [ ] D [ ] E
[ ] Other
Backfill placed from ft. to ft. Material
Gravel placed from ft. to ft. Size of gravel

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	8"	+1	141	.250	[X]	[ ]	[X]	[ ]
Liner:								

Final location of shoe(s)

(7) PERFORATIONS/ SCREENS:
Perforations Method
Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner

(8) WELL TESTS: Minimum testing time is 1 hour
[ ] Pump [ ] Bailer [X] Air [ ] Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
800+		705	1 hr.

Temperature of Water 72° Depth Artesian Flow Found
Was a water analysis done? [ ] Yes By whom
Did any strata contain water not suitable for intended use? [ ] Too little
[ ] Salty [ ] Muddy [ ] Odor [ ] Colored [ ] Other
Depth of strata

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude Longitude
Township 2N N or S. Range 41E E or W. WM
Section 29 NW ¼ SW ¼
Tax Lot Lot Block Subdivision
Street Address of Well (or nearest address) Minam, OR

(10) STATIC WATER LEVEL:
29 ft. below land surface. Date 8-19-92
Artesian pressure lb per square inch Date

(11) WATER BEARING ZONES:
Depth at which water was first found 249

From	To	Estimated Flow Rate	SWL
249	256	60	2
287	329	150	2
525	542	300	2
611	653	300	2

(12) WELL LOG:
Ground elevation

Material	From	To	SWL
Brown clay	0	1	
Gravel	1	29	
Gravel & brown clay	29	40	
Brown basalt	40	67	
Gray basalt	67	78	
Red & brown basalt	78	82	
Red & green basalt	82	84	
Brown basalt	84	97	
Black basalt	97	116	
Black & brown basalt with green soapstone	116	131	
Gray basalt	131	157	
Red & brown basalt	157	164	
Gray basalt	164	191	
Brown basalt with yellow soapstone	191	196	
Gray basalt	196	249	
Red basalt	249	256	u
Brown basalt	256	270	
Gray basalt	270	287	
	(Cont. Pg.		

Date started 8-10-92 Completed 8-19-92

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.
WWC Number
Signed Date

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
WWC Number
Signed Patrick Wallace Date 9-1-9

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STATE OF OREGON

WATER WELL REPORT
(as required by ORS 537.765)

START CARD # 41992 (Pa...

(1) OWNER: Well Number

Name U.S. Dept. of Energy, BPA
Address P.O. Box 3621
City Portland State OR Zip 97208

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD:
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☑ Other Exploratory

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☑ No Depth of Completed Well 705 ft.
Explosives used ☐ Yes ☑ No Type Amount

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☐ Other
Backfill placed from ft. to ft. Material
Gravel placed from ft. to ft. Size of gravel

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS / SCREENS:
☐ Perforations Method
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.

Temperature of Water Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

C-60

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude Longitude
Township 2N N or S. Range 41E E or W. WM
Section 29 NW ¼ SW ¼
Tax Lot Lot Block Subdivision
Street Address of Well (or nearest address) Minam, OR

(10) STATIC WATER LEVEL:
29 ft. below land surface. Date 8-19-92
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found 249

From	To	Estimated Flow Rate	SWL

(12) WELL LOG:
Ground elevation

Material	From	To	SWL
Red & brown basalt with green & yellow soapstone	287	329	W...
Black basalt	329	333	
Red basalt	333	340	
Gray basalt	340	412	
Red & brown basalt	412	448	
Brown basalt	448	456	
Gray basalt	456	525	
Red basalt with yellow soapstone	525	542	W...
Brown basalt with yellow soapstone	542	586	
Gray basalt	586	611	
Red & brown basalt	611	653	W...
Gray basalt	653	677	
Gray basalt with green soapstone	677	705	

Date started 8-10-92 Completed 8-19-92

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

WWC Number
Signed Date

(bonded) Water well Constructor Certification
I accept responsibility for the construction alteration or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 12...
Signed Patrick Wallace Date 9-1-9...

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STATE OF OREGON

WATER WELL REPORT

as required by ORS 537.765)

(START CARD) # 41993

(1) OWNER:
Well Number ______

Name U.S. Dept. of Energy, Bonneville Power

Address P.O. Box 3621

City Portland State OR Zip 97208

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD:
☑ Rotary Air ☐ Rotary Mud ☐ Cable

☐ Other

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☑ Other Exploratory

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☑ No Depth of Completed Well 807 ft.

Explosives used ☐ Yes ☑ No Type ______ Amount ______

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
12"	0	105	Cement	0	105	72 sacks
8"	105	807				

How was seal placed: Method ☐ A ☐ B ☑ C ☐ D ☐ E

☐ Other

Backfill placed from ______ ft. to ______ ft. Material ______

Gravel placed from ______ ft. to ______ ft. Size of gravel ______

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	8"	+1	105	.250	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) ______

(7) PERFORATIONS/SCREENS:
☐ Perforations Method ______

☐ Screens Type ______ Material ______

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is I hour
☐ Pump ☐ Bailer ☑ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	time
400		807	1 hr.

Temperature of Water 56° Depth Artesian Flow Found ______

Was a water analysis done? ☐ Yes By whom ______

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ other ______

Depth of strata ______

(9) LOCATION OF WELL by legal description:
County Wallowa Latitude ______ Longitude ______

Township 0r.S Range 48E E or W. W'

Section 10 NE ¼ SE ¼

Tax Lot ______ Lot ______ Block ______ Subdivision ______

Street Address of Well (or nearest address) South of Imnaha OR

(10) STATIC WATER LEVEL:
ft. below land surface Date 8-26-

Artesian pressure ______ lb. per square inch. Date ______

(11) WATER BEARING ZONES:
Depth at which water was first found 321

From	To	Estimated Flow Rate	SWL
321	341	350	[illegible]
687	716	50	[illegible]

(12) WELL LOG:
Ground elevation ______

Material	From	To	SWL
Brown clay soil	0	2	
Brown clay & gravel	2	37	
Gray basalt	37	77	
Brown basalt	77	79	
Gray basalt	79	112	
Brown basalt	112	119	
Gray basalt	119	160	
Brown & gray basalt	160	171	
Gray basalt	171	321	
Brown & gray basalt	321	341	W
with green soapstone			
Gray basalt	341	687	
Brown & gray basalt	687	716	W
with green soapstone			
Gray basalt	716	747	
Brown & gray clay stone	747	788	
Weathered granite	7	807	

Date started 8-20-92 Completed 8-26-92

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, alteration, or aban[donment of this well is in compliance with Oregon well construction standards. Ma[terials] used and information reported above are true to my best knowledge and belief.

WWC Number ______

Signed ______ Date ______

(bonded) Water Well Constructor Certification:

I accept responsibility for the construction, alteration, or abandonment work [per]formed on this well during the construction dates reported above. All work perfo[rmed] during this time is in compliance with Oregon well construction standards. This r[eport is true] to the best of my knowledge and belief.

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WWC Number 12

Signed Patrick Wallace Date 9-1-9

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MINAM WELL STEP-RATE PUMP TEST
9/8/92

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	DEPTH TO WATER (FEET)	DRAWDOWN (FEET)	REMARKS
15:28	0.0		29.63	0	
15:30	0.0				
15:31	1.0	150	53.77	24.14	
15:32	2.0		53.09	23.46	
15:33	3.0		53.13	23.5	
15:34	4.0		53.28	23.65	
15:35	5.0		54.39	24.76	
15:36	6.0		54.45	24.82	
15:37	7.0		54.53	24.9	
15:38	8.0		54.61	24.98	
15:39	9.0		54.70	25.07	
15:40	10.0		54.76	25.13	
15:41	11.0		54.80	25.17	
15:42	12.0		54.85	25.22	
15:44	14.0	150	54.92	25.29	
15:46	16.0		54.93	25.3	
15:48	18.0		54.97	25.34	
15:50	20.0		54.91	25.28	
15:52	22.0	150	54.95	25.32	
15:54	24.0		54.95	25.32	
15:56	26.0		54.98	25.35	
15:58	28.0	150	55.00	25.37	
16:00	30.0		55.17	25.54	
16:02	32.0		55.19	25.56	
16:04	34.0		55.20	25.57	
16:06	36.0		55.20	25.57	
16:08	38.0		55.22	25.59	
16:10	40.0		55.24	25.61	
16:11	1.0	250	72.3	42.67	
16:12	2.0		74.13	44.5	
16:13	3.0		74.75	45.12	
16:14	4.0		74.99	45.36	
16:15	5.0		75.13	45.5	
16:16	6.0		75.95	46.32	
16:17	7.0		76.57	46.94	
16:18	8.0	250	76.69	47.06	
16:19	9.0		76.88	47.25	
16:20	10.0		76.97	47.34	
16:21	11.0		76.99	47.36	
16:22	12.0		76.97	47.34	
16:24	14.0		76.99	47.36	

MINAM WELL STEP-RATE PUMP TEST
9/8/92

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	DEPTH TO WATER (FEET)	DRAWDOWN (FEET)	REMARKS
16:26	16.0	240	78.18	48.55	
16:27	17.0		78.54	48.91	
16:28	18.0	250	78.57	48.94	
16:30	20.0		78.56	48.93	
16:32	22.0	250	78.45	48.82	
16:34	24.0		78.50	48.87	
16:36	26.0		78.62	48.99	
16:38	28.0		78.76	49.13	
16:40	30.0		78.68	49.05	
16:45	35.0		78.55	48.92	
16:50	40.0		78.50	48.87	
16:52	2.0	340	92.91	63.28	
16:53	3.0		99.45	69.82	
16:54	4.0		99.87	70.24	
16:55	5.0	340	99.90	70.27	
16:56	6.0		99.87	70.24	
16:57	7.0		99.87	70.24	
16:58	8.0	345	99.81	70.18	
16:59	9.0		99.78	70.15	
17:oo	10.0		99.85	70.22	
17:02	12.0	345	99.88	70.25	
17:04	14.0		99.96	70.33	
17:06	16.0		99.99	70.36	
17:08	18.0		100.00	70.37	
17:lO	20.0		100.07	70.44	
17:12	22.0	340-345	100.01	70.38	
17:14	24.0		100.12	70.49	
17:16	26.0	340	100.23	70.6	
17:18	28.0		100.20	70.57	
17:20	30.0	430	100.24	70.61	
17:21	1.0	410	118.70	89.07	
17:22	2.0	410-415	119.30	89.67	
17:23	3.0		119.85	90.22	
17:24	4.0		119.98	90.35	
17:25	5.0		120.14	90.51	
17:26	6.0		120.21	90.58	
17:27	7.0		120.32	90.69	
17:28	8.0	410	120.40	90.77	
17:29	9.0		120.40	90.77	
17:30	10.0		120.49	90.86	
17:32	12.0	410	120.55	90.92	

MINAM WELL STEP-RATE PUMP TEST

9/8/92

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	DEPTH TO WATER FEET)	DRAWDOWN (FEET)	REMARKS
17:34	14.0		120.51	90.88	
17:36	16.0		120.63	91	
17:38	18.0		120.73	91.1	
17:40	20.0		120.78	91.15	

MINAM WELL CONSTANT RATE PUMPING TEST
SEPTEMBER 9-11, 1992

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	DEPTH TO WATER (FEET)	DRAWDOWN (FEET)	REMARKS
7:28	0.0	0	29.84	0	Pretest static
7:30	0.0			0	Start pump test
7:31:00	1.0	450	106.95	77.11	Reduce flow
7:32	2.0	400	115.50	85.66	
7:33:00	3.0		113.53	83.69	
7:34	4.0		113.43	83.59	Back pressure = 0
7:35	5.0	400	113.89	84.05	
7:36	6.0		114.10	84.26	
7:37	7.0		114.37	84.53	
7:38	8.0		114.55	84.71	
7:39	9.0		114.73	84.89	
7:40	10.0		114.82	84.98	
7:42	12.0	390	115.05	85.21	Boost flow slightly
7:44	14.0	400	115.90	86.06	
7:45	15.0		116.03	86.19	
7:46	16.0	395	116.09	86.25	Boost flow slightly
7:48	18.0	400	116.63	86.79	
7:49	19.0		116.75	86.91	
7:50	20.0	400	116.80	86.96	Totalizer = 43,600 gal
7:52	22.0		116.94	87.10	(includes step test)
7:54	24.0		117.06	87.22	
7:56	26.0		117.03	87.19	
7:58	28.0	395	117.03	87.19	Boost flow slightly
8:00	30.0	400	117.48	87.64	
8:02	32.0		117.54	87.70	
8:05	35.0	395	117.64	87.80	Boost flow slightly
8:10	40.0	400	117.92	88.08	
8:12	42.0				T = 69" F
8:15	45.0	400	118.03	88.19	pH = 6.02
8:21	51.0	395	118.12	88.28	EC = 225 µS
8:25	55.0	400	118.73	88.89	
8:30	60.0		118.50	88.66	
8:35	65.0		118.49	88.65	
8:40	70.0	400	118.58	88.74	Boost flow slightly
8:45	75.0	395	118.66	88.82	
8:50	80.0	400	119.00	89.16	
8:55	85.0	400	118.97	89.13	
9:00	90.0	395	118.93	89.09	Boost flow slightly
9:10	100.0	400	119.10	89.26	
9:15	105.0	395			Boost flow slightly
9:20	110.0	400	119.57	89.73	

MINAM WELL CONSTANT RATE PUMPING TEST
SEPTEMBER 9-I 1, 1992

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	DEPTH TO WATER (FEET)	DRAWDOWN (FEET)	REMARKS
9:30	120.0	400	119.55	89.71	
9:37	127.0	395			Boost to 400
9:45	135.0	400	119.87	90.03	
10:00	150.0	400	119.96	90.12	
10:15	165.0	395	119.99	90.15	Boost to 400
10:30	180.0	400	120.50	90.66	
10:45	195.0				Hotel well = 3.2 ft btoc
11:00	210.0	400	120.39	90.55	
11:10	220.0				School well dry to 90 ft
11:30	240.0	395-400	120.42	90.58	Boost flow slightly
12:00	270.0	400	121.02	91.18	
12:15	285.0	395-400			Boost flow slightly
12:30	300.0	400	121.36	91.52	
12:50	320.0	395-400			Boost flow slightly
13:00	330.0	400	121.54	91.70	
13:30	360.0	400	121.61	91.77	
13:35	365.0				T = 70° F
14:00	390.0	400	121.64	91.80	pH = 7.00
14:30	420.0	400	121.58	91.74	EC = 199 µS
15:30	480.0	400	121.68	91.84	No detectable H_2S
16:30	540.0	400	121.67	91.83	
17:10	580.0				No detectable sand
17:30	600.0	400	121.65	91.81	
18:15	645.0				Hotel well = 3.1 ft btoc
18:30	660.0	400	121.85	92.01	T = 69° F
19:30	720.0	400	122.07	92.23	pH = 7.35
23:30	960.0	400	122.48	92.64	EC= 199 µS
3:30	1200.0	400	122.81	92.97	
6:00	1350.0	400	123.04	93.20	
7:30	1440.0	410	123.19	93.35	Reduce flow to 400
7:40	1450.0				T = 69° F
					pH = 7.66
					EC = 201 µS
7:50	1460.0				Collect GW samples
9:40	1570.0	395			Boost flow to 400
10:30	1620.0	400	122.50	92.66	
11:40	1690.0	395			Boost flow to 400
12:30	1640.0				Htl well WL ?-pump on
13:15	1695.0	395			Boost flow to 400
13:30	1800.0	400	123.08	93.24	
15:30	1920.0	400	122.96	93.12	

MINAM WELL CONSTANT RATE PUMPING TEST
SEPTEMBE R9-I 1, 1992

TIME	ELAPSED TIME(MIN)	FLOWRATE (GPM)	DEPTH TO WATER (FEET)	DRAWDOWN (FEET)	REMARKS
16:30	1980.0	400	122.94	93.10	
18:00	2070.0	400	123.02	93.18	
19:30	2160.0		123.20	93.36	
23:30	2400.0		123.73	93.89	
3:30	2640.0		123.93	94.09	
5:25	2755.0				Collect GW samples
5:30	2760.0	400	123.91	94.07	
5:40	2770.0				Pump off T = 69° F pH = 8.00 EC = 331 µS Tot. Q = 1.163.100 gal (includes step test)

MINAM WELL CONSTANT RATE PUMP TEST RECOVERY

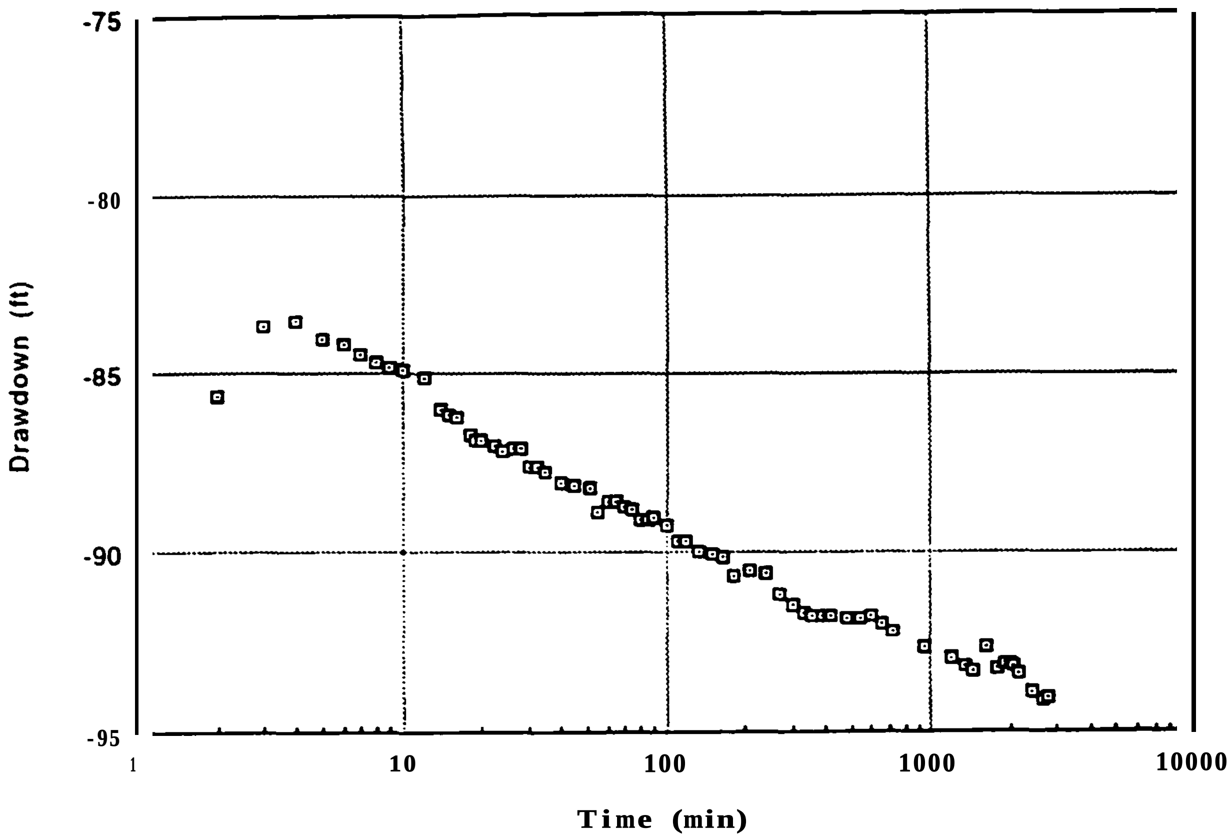
9/11/92

TIME	ELAPSED TIME t (MIN)	RECOVERY TIME t' (MIN)	t/t'	DEPTH TO WATER (FEET)	RESIDUAL DRAWDOWN (FEET)	REMARKS
5:40	2770.0	0		123.91	94.28	Pump off
5:40:30	2770.5	0.5	5541.0	66.7	37.07	
5:41	2771.0	1	2771.0	44.4	14.77	
5:42	2772.0	2	1386.0	38.71	9.08	
5:43	2773.0	3	924.3	36.97	7.34	
5:44	2774.0	4	693.5	36.08	6.45	
5:45	2775.0	5	555.0	35.50	5.87	
5:46	2776.0	6	462.7	35.21	5.58	
5:47	2777.0	7	396.7	34.95	5.32	
5:48	2778.0	8	347.3	34.72	5.09	
5:49	2779.0	9	308.8	34.52	4.89	
5:50	2780.0	10	278.0	34.38	4.75	
5:51	2781.0	11	252.8	34.14	4.51	
5:52	2782.0	12	231.8	34.11	4.48	
5:54	2784.0	14	198.9	33.92	4.29	
5:56	2786.0	16	174.1	33.77	4.14	
5:58	2788.0	18	154.9	33.61	3.98	
6:00	2790.0	20	139.5	33.47	3.84	
6:02	2792.0	22	126.9	33.34	3.71	
6:04	2794.0	24	116.4	33.26	3.63	
6:06	2796.0	26	107.5	33.15	3.52	
6:08	2798.0	28	99.9	33.07	3.44	
6:10	2800.0	30	93.3	32.93	3.30	
6:15	2805.0	35	80.1	32.77	3.14	
6:25	2815.0	45	62.6	32.53	2.90	
6:30	2820.0	50	56.4	32.39	2.76	
6:35	2825.0	55	51.4	32.30	2.67	
6:40	2830.0	60	47.2	32.29	2.66	
6:50	2840.0	70	40.6	32.10	2.47	
7:00	2850.0	80	35.6	31.99	2.36	
7:10	2860.0	90	31.8	31.97	2.34	
7:20	2870.0	100	28.7	31.90	2.27	
7:30	2880.0	110	26.2	31.83	2.20	
7:40	2890.0	120	24.1	31.76	2.13	
7:55	2905.0	135	21.5	31.67	2.04	
8:04	2914.0	144	20.2	31.67	2.04	
8:05	2915.0					Pulling pump
8:30	2940.0	170	17.3	31.61	1.98	Pump out
9:00	2970.0	200	14.9	31.55	1.92	
9:30	3000.0	230	13.0	31.50	1.87	
10:00	3030.0	260	11.7	31.48	1.83	

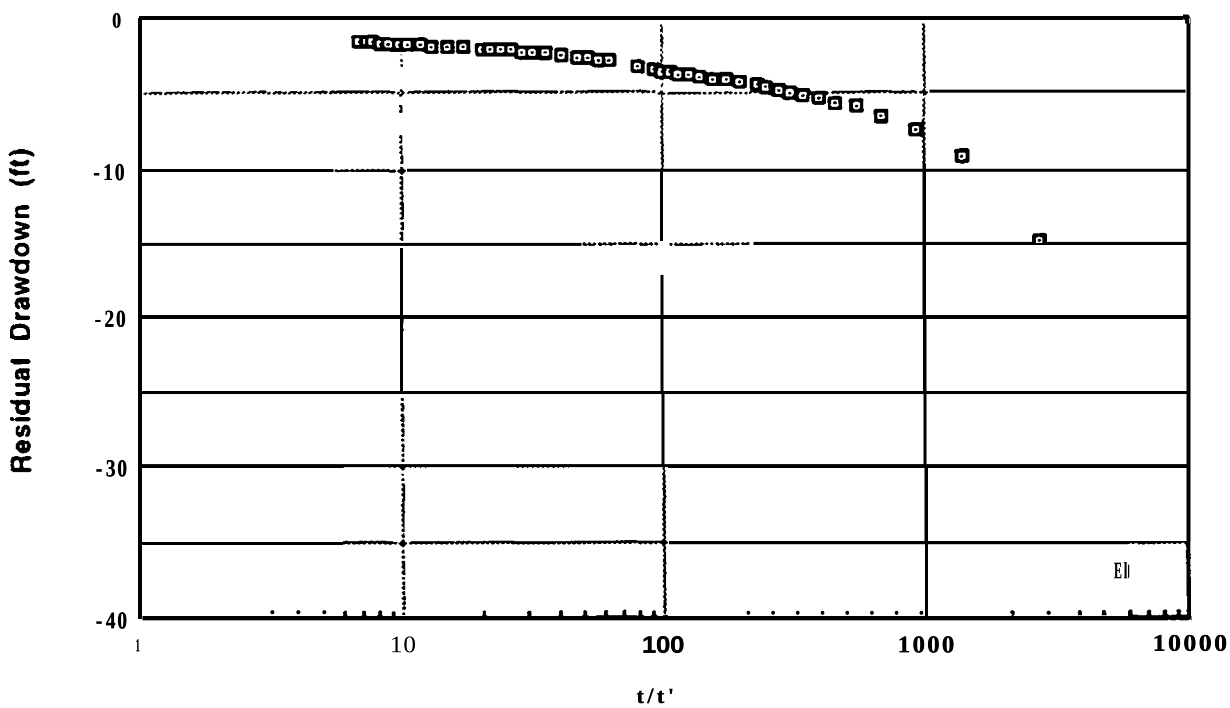
MINAM WELL CONSTANT RATE PUMP TEST RECOVERY
9/11/92

TIME	ELAPSED TIME t (MIN)	RECOVERY TIME t' (MIN)	t/t'	DEPTH TO WATER (FEET)	RESIDUAL DRAWDOWN (FEET)	REMARKS
10:30	3060.0	290	10.6	31.42	1.79	
11:00	3090.0	320	9.7	31.37	1.74	
11:30	3120.0	350	8.9	31.36	1.73	
12:00	3150.0	380	8.3	31.34	1.71	
12:30	3180.0	410	7.8	31.30	1.67	
13:00	3210.0	440	7.3	31.28	1.65	
13:30	3240.0	470	6.9	31.23	1.60	

MINAM WELL CONSTANT RATE PUMP TEST



MINAM WELL CONSTANT RATE PUMP TEST RECOVERY



CATHERINE CREEK WELL STEP-RATE FLOW TEST
9/1/92

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	HEAD (FEET)	DRAWDOWN (FEET)	REMARKS
16:40	0.0		23.78	0	Pretest static (press. gauge)
17:35	0.0		23.78	0	
18:06	0.0	175-179	23.78	0	
18:06:30	0.5	175-179	19.14	4.64	
18:07	1.0	175-179	19.14	4.64	
18:08	2.0	175-179	19.14	4.64	
18:09	3.0	175	19.14	4.64	
18:10	4.0	175	19.02	4.76	
18:11	5.0	175	19.02	4.76	
18:12	6.0	175	19.02	4.76	
18:14	8.0	175	18.79	4.99	
18:16	10.0	175	18.79	4.99	
18:18	12.0	175	18.79	4.99	
18:20	14.0	175	18.56	5.22	
18:22	16.0	172-175	18.56	5.22	
18:24	18.0	175-179	18.33	5.45	
18:26	20.0	175	18.10	5.68	
18:28	22.0	175	18.10	5.68	
18:30	24.0	175	18.10	5.68	
18:32	26.0	175	18.10	5.68	
18:34	28.0	175	18.10	5.68	
18:36	30.0		17.98	5.8	
18:36:30	0.5	250	14.62	9.16	
18:37	1.0	250	14.62	9.16	
18:38	2.0	250	14.50	9.28	
18:39	3.0	248-250	14.38	9.4	
18:40	4.0	250	14.38	9.4	
18:41	5.0	250	14.38	9.4	
18:42	6.0	250	14.38	9.4	
18:43	7.0	250	14.38	9.4	
18:44	8.0	250	14.15	9.63	
18:45	9.0	250	14.15	9.63	
18:47	11.0	250	13.92	9.86	
18:48	12.0	250	13.92	9.86	
18:50	14.0	248	13.92	9.86	
18:52	16.0	250	13.69	10.09	
18:54	18.0	250	13.69	10.09	
18:56	20.0	250	13.46	10.32	
18:58	22.0	250	13.46	10.32	
19:00	24.0	250	13.34	10.44	
19:02	26.0	250	13.34	10.44	

CATHERINE CREEK WELL STEP-RATE FLOW TEST
9/1/92

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	HEAD (FEET)	DRAWDOWN (FEET)	REMARKS
19:04	28.0	250	13.22	10.56	
19:06	30.0	250	13.22	10.56	
19:07	1.0	370	5.80	17.98	
19:08	2.0	365	5.80	17.98	
19:09	3.0	362	5.80	17.98	
19:10	4.0	360	5.80	17.98	
19:11	5.0	358	5.80	17.98	
19:12	6.0	357	5.80	17.98	
19:13	7.0	357	5.57	18.21	
19:14	8.0	355	5.57	18.21	
19:15	9.0	354	5.57	18.21	
19:16	10.0	352	5.57	18.21	
19:18	12.0	351	5.57	18.21	
19:20	14.0	350	5.57	18.21	
19:22	16.0	348	5.57	18.21	
19:24	18.0	347	5.57	18.21	
19:26	20.0	346	5.57	18.21	
19:28	22.0	344	5.57	18.21	
19:30	24.0	343	5.57	18.21	
19:32	26.0	342	5.34	18.44	
19:34	28.0	340	5.34	18.44	
19:36	30.0	338	5.34	18.44	

CATHERINE CREEK WELL CONSTANT RATE FLOW TEST
SEPTEMBER 2-3, 1992

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	HEAD (FEET)	DRAWDOWN (FEET)	REMARKS
7:20	0.0	0	23.78	0	Pretest equip. calibration
7:32	0.0	0	23.78	0	
7:40	0.0	275	23.78	0	Start flow test
7:40:30	0.5	275	15.08	8.70	
7:41	1.0	275	15.08	8.70	
7:41:30	1.5	275	14.85	8.93	
7:42	2.0	275	14.62	9.16	
7:43	3.0	275	14.62	9.16	
7:44	4.0	275	14.50	9.28	
7:45	5.0	275	14.15	9.63	
7:46	6.0	275	14.15	9.63	
7:47	7.0	275	14.15	9.63	
7:48	8.0	275	13.92	9.86	
7:49	9.0	275	13.92	9.86	
7:50	10.0	275	13.69	10.09	
7:52	12.0	275	13.46	10.32	
7:54	14.0	275	13.46	10.32	
7:56	16.0	275	13.46	10.32	T = 50° F
7:58	18.0	275	13.22	10.56	pH =5.81
8:00	20.0	275	12.99	10.79	EC = 231 µS
8:02	22.0	275	12.76	11.02	
8:04	24.0	275	12.53	11.25	
8:06	26.0	275	12.53	11.25	
8:08	28.0	275	12.53	11.25	
8:10	30.0	275	12.30	11.48	
8:15	35.0	275	12.06	11.72	
8:20	40.0	275	12.06	11.72	
8:25	45.0	275	11.83	11.95	
8:30	50.0	275	11.60	12.18	
8:35	55.0	275	11.37	12.41	
8:40	60.0	275	11.14	12.64	No detectable H2S
8:50	70.0	275	10.90	12.88	
9:00	80.0	275	10.44	13.34	
9:10	90.0	275	10.21	13.57	
9:20	100.0	275	9.98	13.80	
9:30	110.0	275	9.51	14.27	
9:40	120.0	275	9.28	14.50	
9:55	135.0	275	8.58	15.20	
10:10	150.0	275	8.35	15.43	
10:20	160.0	275	8.12	15.66	
lo:25	165.0	275	8.12	15.66	

CATHERINE CREEK WELL CONSTANT RATE FLOW TEST
SEPTEMBER 2-3, 1992

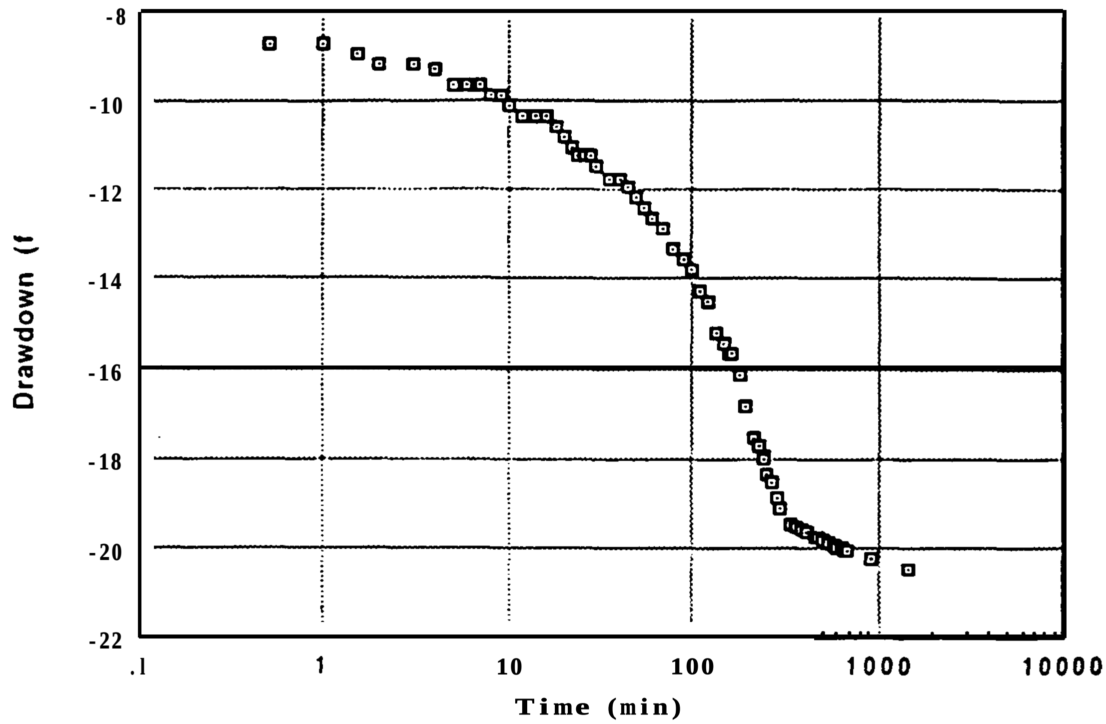
TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	HEAD (FEET)	DRAWDOWN (FEET)	REMARKS
10:40	180.0	275	7.66	16.12	
10:55	195.0	275	6.96	16.82	
11:10	210.0	275	6.26	17.52	
11:25	225.0	275	6.03	17.75	
11:40	240.0	275	5.80	17.98	
11:43	243.0	275	5.75	18.03	Change from gauge to tube
11:55	255.0	275	5.43	18.35	for head readings
12:10	270.0	275	5.25	18.53	
12:25	285.0	275	4.88	18.90	
12:40	300.0	275	4.63	19.15	
13:20	340.0	268	4.30	19.48	Valve completely open
13:30	350.0				T = 52° F
13:40	360.0	264	4.24	19.54	pH = 7.25
14:10	390.0	259	4.20	19.58	EC = 220 µS
14:40	420.0	254	4.10	19.68	No detectable H2S
15:10	450.0	250	4.03	19.75	
15:40	480.0	245	3.98	19.80	
16:10	510.0	241	3.94	19.84	
16:40	540.0	237	3.90	19.88	
17:10	570.0	232	3.85	19.93	
17:40	600.0	228	3.80	19.98	
18:10	630.0	225	3.77	20.01	
18:40	660.0	223	3.74	20.04	
19:10	690.0	218	3.70	20.08	
22:55	915.0	196	3.53	20.25	
7:55	1455.0	175	3.33	20.45	
8:00	1460.0				Collect GW samples
8:13	1473.0				T = 52° F
8:15	1475.0	0			EC = 288 µS
					Flow off @ 0815

CATHERINE CREEK WELL CONSTANT RATE FLOW TEST RECOVERY

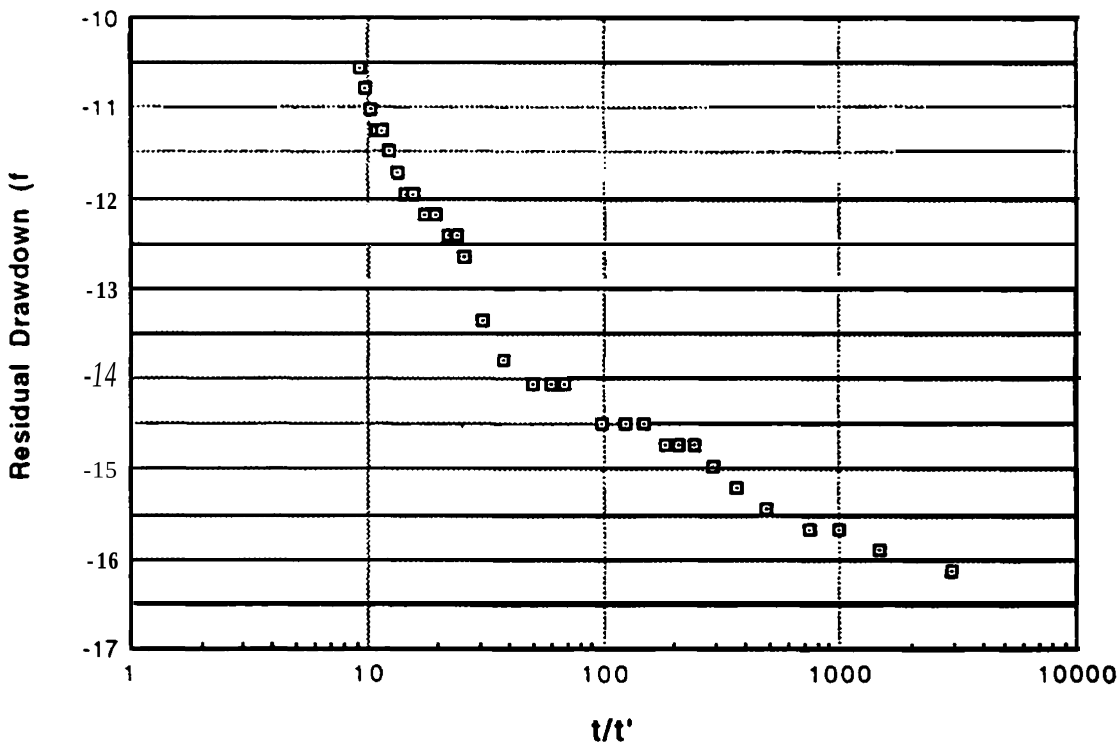
9/3/92

TIME	ELAPSED TIME t (MIN)	RECOVERY TIME t (MIN)	t/t'	PRESSURE HEAD (FEET)	RESIDUAL DRAWDOWN (FEET)	REMARKS
8:14	1474.0	0		3.48	20.30	
8:15	1475.0	0		3.48	20.30	Flow off
8:15:30	1475.5	0.5	2951.0	7.66	16.12	
8:16	1476.0	1	1476.0	7.89	15.89	
8:16:30	1476.5	1.5	984.3	8.12	15.66	
8:17	1477.0	2	738.5	8.12	15.66	
8:18	1478.0	3	492.7	8.35	15.43	
8:19	1479.0	4	369.8	8.58	15.20	
8:20	1480.0	5	296.0	8.82	14.96	
8:21	1481.0	6	246.8	9.05	14.73	
8:22	1482.0	7	211.7	9.05	14.73	
8:23	1483.0	8	185.4	9.05	14.73	
8:25	1485.0	10	148.5	9.28	14.50	
8:27	1487.0	12	123.9	9.28	14.50	
8:30	1490.0	15	99.3	9.28	14.50	
8:37	1497.0	22	68.0	9.74	14.04	
8:40	1500.0	25	60.0	9.74	14.04	
8:45	1505.0	30	50.2	9.74	14.04	
8:55	1515.0	40	37.9	9.98	13.80	
9:05	1525.0	50	30.5	10.44	13.34	
9:15	1535.0	60	25.6	11.14	12.64	
9:20	1540.0	65	23.7	11.37	12.41	
9:25	1545.0	70	22.1	11.37	12.41	
9:35	1555.0	80	19.4	11.60	12.18	
9:45	1565.0	90	17.4	11.60	12.18	
9:55	1575.0	100	15.8	11.83	11.95	
10:05	1585.0	110	14.4	11.83	11.95	
10:15	1595.0	120	13.3	12.06	11.72	
lo:25	1605.0	130	12.3	12.30	11.48	
10:35	1615.0	140	11.5	12.53	11.25	
10:45	1625.0	150	10.8	12.53	11.25	
10:55	1635.0	160	10.2	12.76	11.02	
11:05	1645.0	170	9.7	12.99	10.79	
11:15	1655.0	180	9.2	13.22	10.56	

CATHERINE CREEK WELL CONSTANT RATE FLOW TEST

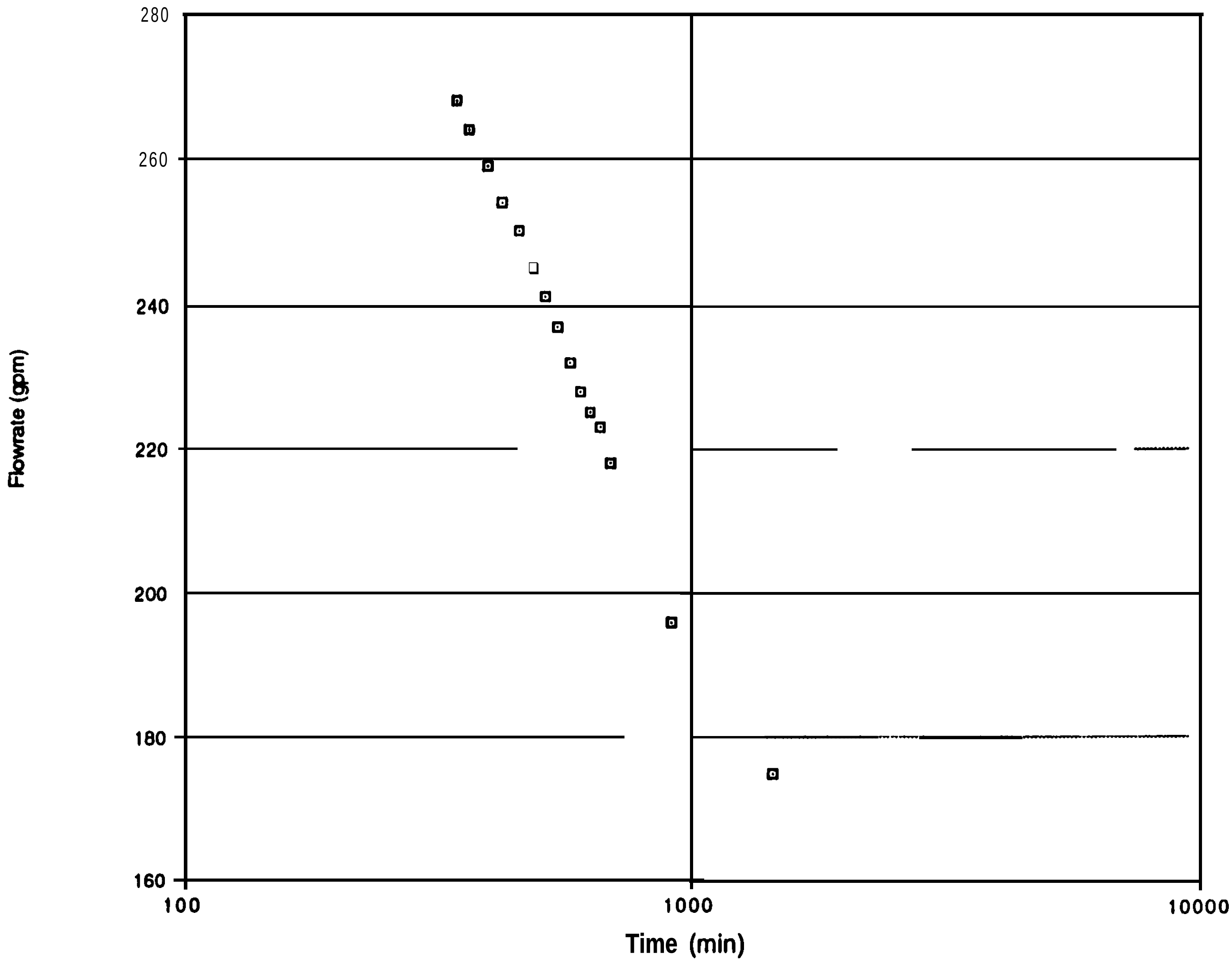


CATHERINE CREEK CONSTANT RATE FLOW TEST RECOVERY



C-17

CATHERINE CREEK WELL CONSTANT DRAWDOWN FLOW TEST



IMNAHA WELL STEP-RATE PUMP TEST

9/14/92

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	DEPTH TO WATER (FEET)	DRAWDOWN (FEET)	REMARKS
12:10	0.0	0	14.20	0	Pretest static
12:32	0.0				Start pumping
12:33:30	1.5	150	34.43	20.23	
12:34	2.0		36.40	22.2	
12:35:30	3.5		38.40	24.2	
12:36	4.0		38.91	24.71	
12:37	5.0		40.00	25.8	
12:38	6.0	150	40.94	26.74	Back pressure = 94 psi
12:39	7.0		41.53	27.33	
12:40	8.0		42.18	27.98	
12:41	9.0		42.73	28.53	
12:42	10.0		43.19	28.99	
12:43	11.0	150	43.52	29.32	
12:44	12.0		43.90	29.7	
12:46	14.0		44.49	30.29	Back pressure = 92 psi
12:48	16.0	150	44.90	30.7	
12:50	18.0		45.30	31.1	
12:52	20.0		45.60	31.4	
12:54	22.0	150	45.94	31.74	Back pressure = 92 psi
12:56	24.0		46.15	31.95	
12:58	26.0		46.40	32.2	
13:00	28.0	150	46.63	32.43	
13:02	30.0		46.83	32.63	Boost flow to 250
13:03	1.0	250	56.00	41.8	
13:04	2.0		60.97	46.77	Back pressure = 57 psi
13:05	3.0		64.30	50.1	
13:06	4.0		66.50	52.3	
13:07	5.0	250	68.12	53.92	
13:08	6.0		69.51	55.31	
13:09	7.0		70.54	56.34	
13:10	8.0	250	71.58	57.38	Back pressure = 55 psi
13:11	9.0		72.35	58.15	
13:12	10.0		73.04	58.84	
13:13	11.0		73.67	59.47	
13:14	12.0	250	74.13	59.93	
13:16	14.0		75.10	60.9	
13:18	16.0		75.80	61.6	
13:20	18.0	235	76.41	62.21	Boost flow to 250
13:21	19.0	250	78.38	64.18	
13:22	20.0		79.20	65	
13:23	21.0	250	79.84	65.64	

IMNAHA WELL STEP-RATE PUMP TEST
9/I 4/92

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	DEPTH TO WATER (FEET)	DRAWDOWN (FEET)	REMARKS
13:24	22.0		80.31	66.11	Back pressure = 50 psi
13:27	25.0	250	81.01	66.81	
13:30	28.0		81.88	67.68	
13:32	30.0	250	82.35	68.15	Boost flow to 350
13:33	1.0	350	95.18	80.98	
13:34	2.0	340	100.35	86.15	
13:35	3.0		103.26	89.06	
13:36	4.0	335	106.10	91.9	Boost flow
13:37	5.0	350	109.93	95.73	
13:38	6.0	350	111.25	97.05	
13:39	7.0		112.97	98.77	
13:40	8.0	340	115.52	101.32	Back pressure = 17 psi
13:41	9.0	340	115.62	101.42	Boost flow to 350
13:42:30	10.5	350	118.74	104.54	Back pressure = 14 psi
13:44	12.0	345	120.98	106.78	Boost flow to 350
13:45	13.0	350	122.60	108.4	
13:46	14.0	350	124.18	109.98	Back pressure = 13 psi
13:48	16.0		125.90	111.7	
13:50	18.0	345	127.46	113.26	Boost flow to 350
13:52	20.0	350	129.08	114.60	
13:54	22.0	340	130.55	116.35	Boost flow to 350
13:56	24.0	350	132.92	118.72	
13:58	26.0	345	134.53	120.33	
14:oo	28.0	350	135.65	121.45	
14:02	30.0		137.95	123.75	
14:03	1.0	390	140.15	125.95	Boost flow - Gate
14:04	2.0		143.38	129.18	valve is now wide open
14:05	3.0		145.00	130.8	
14:06	4.0	380	146.50	132.3	Back pressure = 0 psi
14:07	5.0		147.93	133.73	
14:08	6.0	375	148.83	134.63	
14:09	7.0		150.09	135.89	
14:10	8.0		150.83	136.63	
14:11	9.0		151.69	137.49	
14:12	10.0	360	152.50	138.3	
14:14	12.0		154.12	139.92	
14:16	14.0	350	155.27	141.07	
14:18	16.0	350	156.18	141.98	
14:20	18.0	345	156.93	142.73	
14:22	20.0	345	156.93	142.73	
14~24	22.0	360	157.40	143.2	

IMNAHA WELL STEP-RATE PUMP TEST
9/14/92

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	DEPTH TO WATER (FEET)	DRAWDOWN (FEET)	REMARKS
14:26	24.0	340	158.02	143.82	
14:28	26.0	345	157.52	143.32	
14:30	28.0		158.66	144.46	
14:32	30.0		159.27	145.07	Pump off

IMNAHA WELL CONSTANT RATE PUMP TEST #1
9/14/92

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	DEPTH TO WATER (FEET)	DRAWDOWN FEET)	REMARKS
12:10	0.0	0	14.20	0	Pre-step-test static
12:32	0.0	0		0	Start step test
14:32	0.0	0		0	Stop step test-recovery
17:00	0.0	0	15.80	1.60	
17:02	0.0				Start pump test
17:04	2.0	280	60.76	46.56	Reducing flow
17:05	3.0		64.96	50.76	
17:06	4.0		68.10	53.90	
17:07	5.0		71.10	56.90	
17:08	6.0		73.20	59.00	Back pressure = 50 psi
17:09	7.0	250-300	74.98	60.78	Boost flow slightly
17:10	8.0	260-310	77.42	63.22	
17:11	9.0	270-290	79.60	65.40	Back pressure = 44 psi
17:12	10.0		81.26	67.06	
17:14	12.0	250-290	84.67	70.47	Boost flow slightly
17:16	14.0	270-290	87.60	73.40	
17:18	16.0	280	89.66	75.46	
17:20	18.0	280	90.21	76.01	
17:22	20.0		91.42	77.22	
17:24	22.0	280	92.38	78.18	
17:26	24.0		93.20	79.00	Back pressure = 38 psi
17:28	26.0	275	93.94	79.74	Boost flow slightly
17:30	28.0	280	95.17	80.97	
17:32	30.0	280	96.27	82.07	
17:37	35.0	280	97.82	83.62	Back pressure = 36 psi
17:42	40.0	270-280	98.99	84.79	Boost flow to 280
17:47	45.0	280	102.13	87.93	Back pressure = 36 psi
17:52	50.0	280	103.48	89.28	
17:57	55.0		104.42	90.22	
18:08	66.0	270	106.00	91.80	Boost flow to 280
18:17	75.0	275	108.71	94.51	Boost flow to 280
18:32	90.0	280	112.83	98.63	
18:47	105.0	280	115.28	101.08	T = 55° F
19:02	120.0	280	116.70	102.50	pH = 7.9
19:32	150.0	280	118.52	104.32	
19:55	173.0	280	119.73	105.53	
21:30	208.0		118.52	104.32	
23:00	298.0				Generator, pump failure
23:25	323.0		27.3	13.10	

IMNAHA WELL CONSTANT RATE PUMP TEST #2
9/15-16/1992

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	DEPTH TO WATER (FEET)	DRAWDOWN (FEET)	REMARKS
14:00	0.0	0	14.97	0	Pretest static
17:38	0.0	0	14.98	0	Pretest static
17:40	0.0				Start pump test
17:41	1.0	200	34.64	19.66	
17:42	2.0	200	40.25	25.27	Back pressure = 83 psi
17:43	3.0		43.96	28.98	
17:44	4.0	200	46.83	31.85	Back pressure = 80 psi
17:45	5.0		48.92	33.94	
17:46	6.0	190	50.65	35.67	Boost flow to 200
17:47	7.0	200	52.00	37.02	Back pressure = 78 psi
17:48	8.0	195	53.18	38.20	Boost flow to 200
17:49	9.0		54.12	39.14	
17:50	10.0	200	54.86	39.88	
17:51	11.0	200	55.62	40.64	Back pressure = 77 psi
17:52	12.0	195	56.26	41.28	Boost flow slightly
17:54	14.0	200	59.38	44.40	Back pressure = 71 psi
17:56	16.0		61.22	46.24	
17:58	18.0	200	62.27	47.29	
18:00	20.0	200	62.86	47.88	
18:02	22.0	200	63.49	48.51	Back pressure = 70 psi
18:04	24.0	200	64.00	49.02	
18:06	26.0	200	64.49	49.51	
18:08	28.0	200	64.93	49.95	Back pressure = 70 psi
18:10	30.0	200	65.27	50.29	
18:15	35.0	200	66.21	51.23	T = 54° F
18:20	40.0	200	66.95	51.97	pH = 8.0
18:25	45.0	200	67.60	52.62	TDS = 80 ppm
18:30	50.0	200	68.15	53.17	Back pressure = 69 psi
18:35	55.0	200	68.33	53.35	
18:40	60.0	200	69.13	54.15	
18:50	70.0	200	70.02	55.04	No detectable H_2S
19:00	80.0	200	70.64	55.66	
19:10	90.0	200	71.25	56.27	
19:20	100.0		71.70	56.72	
19:40	120.0	200	72.47	57.49	
20:10	150.0	195	73.57	58.59	Boost flow to 200
20:40	180.0	200	76.50	61.52	
21:10	210.0		77.3	62.36	
21:40	240.0	200	77.83	62.85	
22:40	300.0	200	78.55	63.57	
23:47	367.0	200	79.02	64.04	

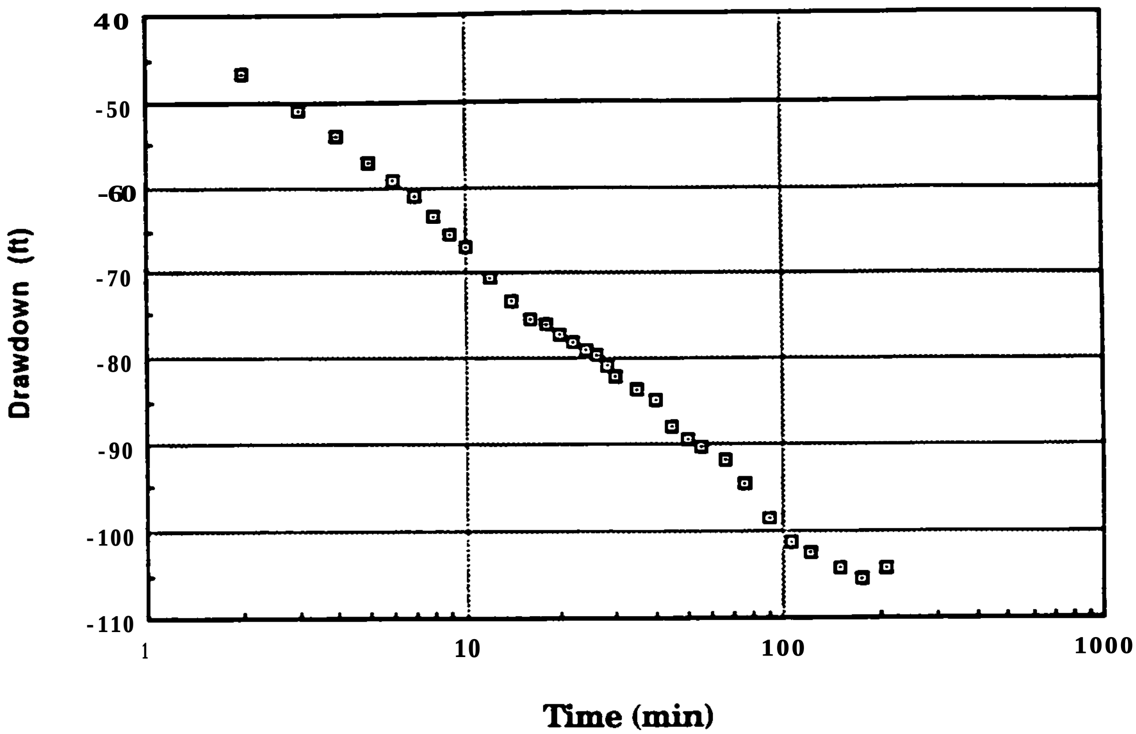
IMNAHA WELL CONSTANT RATE PUMP TEST #2
9/15-16/1992

TIME	ELAPSED TIME (MIN)	FLOWRATE (GPM)	DEPTH TO WATER (FEET)	DRAWDOWN FEET)	REMARKS
3:02	562.0	200	79.53	64.55	
7:05	805.0	200	80.22	65.24	
8:00	860.0				Collect GW samples
8:15	875.0				T = 54° F
8:40	900.0	200	80.14	65.16	pH = 8.0
10:20	1000.0	200	80.16	65.18	No detectable H2S
12:oo	1100.0	200	80.35	65.37	Back pressure = 6 psi
13:20	1180.0	200	80.47	65.49	
15:20	1300.0	200	80.48	65.50	Back pressure = 64 psi
17:oo	1400.0	200	80.63	65.65	
17:10	1410.0				Collect GW samples
17:40	1440.0	200	80.69	65.71	Pump off
					T = 54° F
					pH = 8.0
					TDS = 68 ppm

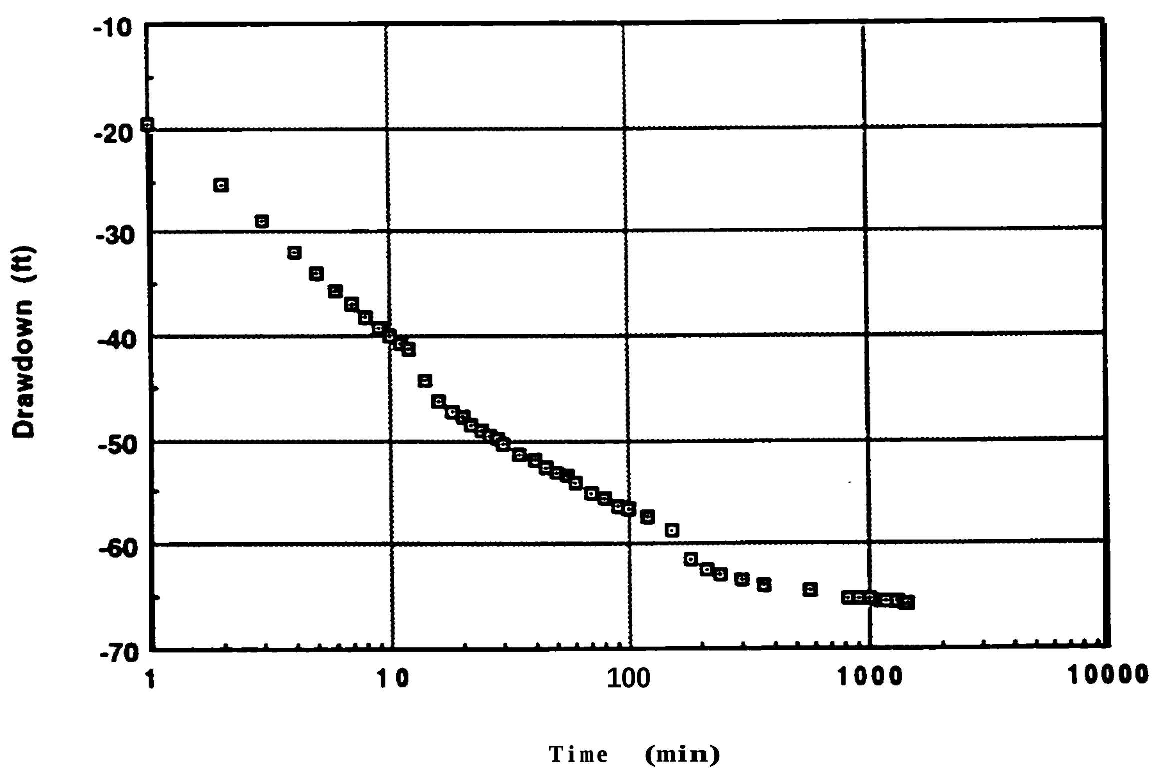
IMNAHA WELL CONSTANT RATE PUMP TEST RECOVERY
9/l 6/92

TIME	ELAPSED TIME t (MIN)	RECOVERY TIME t (MIN)	t/t'	DEPTH TO WATER (FEET)	RESIDUAL DRAWDOWN (FEET)	REMARKS
17:40	1440.0	0		80.69	65.71	Pump off
17:40:30	1440.5	0.5	2881.0	60.90	45.92	
17:41	1441.0	1	1441.0	55.89	40.91	
17:41:30	1441.5	1.5	961 .0	51.57	36.59	
17:42	1442.0	2	721.0	48.70	33.72	
17:43	1443.0	3	481 .0	44.00	29.02	
17:44	1444.0	4	361 .0	40.38	25.4	
17:45	1445.0	5	289.0	37.80	22.82	
17:46	1446.0	6	241.0	35.37	20.39	
17:47	1447.0	7	206.7	33.58	18.6	
17:48	1448.0	8	181.0	32.40	17.42	
17:49	1449.0	9	161.0	31.25	16.27	
17:50	1450.0	10	145.0	30.17	15.19	
17:52	1452.0	12	121.0	28.56	13.58	
17:54	1454.0	14	103.9	27.40	12.42	
17:56	1456.0	16	91.0	26.59	11.61	
17:58	1458.0	18	81 .0	25.91	10.93	
18:00	1460.0	20	73.0	25.33	10.35	
18:02	1462.0	22	66.5	25.17	10.19	
18:04	1464.0	24	61.0	24.45	9.47	
18:06	1466.0	26	56.4	24.05	9.07	
18:08	1468.0	28	52.4	23.70	8.72	
18:10	1470.0	30	49.0	23.50	8.52	
18:15	1475.0	35	42.1	22.86	7.88	
18:20	1480.0	40	37.0	22.35	7.37	
18:25	1485.0	45	33.0	21.90	6.92	
18:30	1490.0	50	29.8	21.42	6.44	
18:35	1495.0	55	27.2	21.10	6.12	
18:41	1501.0	61	24.6	20.68	5.7	
18:50	1510.0	70	21.6	20.25	5.27	
19:oo	1520.0	80	19.0	19.82	4.84	
19:lO	1530.0	90	17.0	19.39	4.41	
19:30	1550.0	110	14.1	18.88	3.9	
19:50	1570.0	130	12.1	18.40	3.42	
2O:lO	1590.0	150	10.6	18.07	3.09	
20:40	1620.0	180	9.0	17.70	2.72	

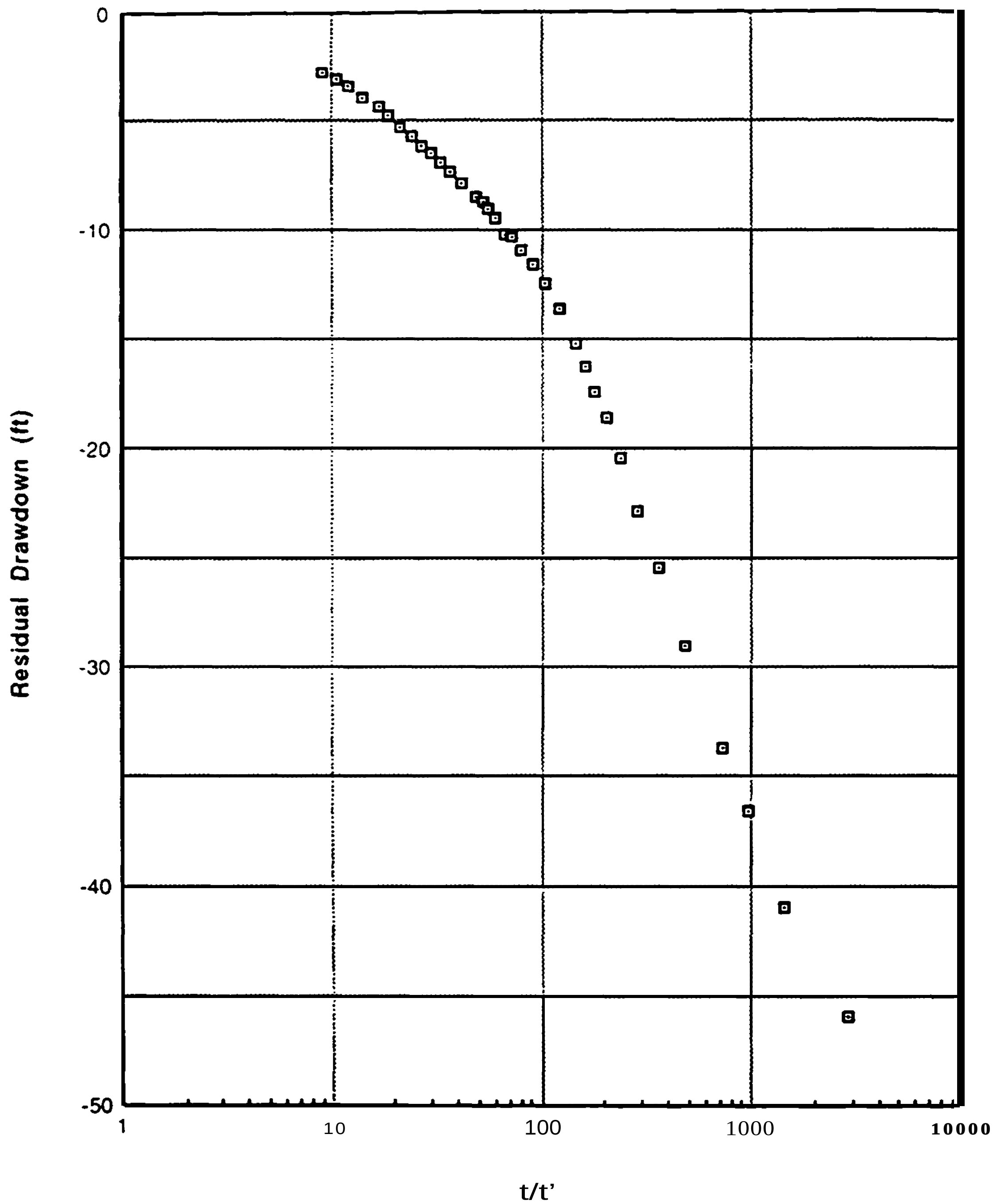
IMNAHA WELL CONSTANT RATE PUMP TEST #1



IMNAHA WELL CONSTANT RATE PUMP TEST #2



IMNAHA WELL CONSTANT RATE PUMP TEST #2 RECOVERY



ALCHEM LABORATORY

104 West 31st Street
Boise, Idaho 83714
(208) 336-1172

LABORATORY REPORT

JAMES M. MONTGOMERY, ENGINEERS
161 E. MALLARD
BOISE, IDAHO 83706

ATTENTION: PAT NAYLOR
SOURCE -: MINAM WELL

DATE COLLECTED - - -09/10/92
TIME COLLECTED - - -7:50
DATE RECEIVED - - - 09/14/92
DATE REPORTED - - - 09/28/92
SUBMITTED : TERRY SCANLON

LAB SAMPLE NUMBER - 27425

Results reported unless noted: (Chemistry Analysis as mg/l) (Bacteria as organisms/100 ml)

ANALYSIS	RESULTS	DATE ANALYZED	ANALYST
ALKALINITY	75.0	09/25/92	JD
AMMONIA as N	<0.05	09/15/92	CI
BICARBONATE	75.0	09/25/92	JD
CALCIUM	16.0	09/18/92	JD
CARBONATE	<1.0	09/25/92	JD
CHLORIDE	2.92	09/16/92	KL
CONDUCTIVITY (umhos/cm)	175	09/14/92	JD
FLUORIDE	0.34	09/17/92	JD
HARDNESS	53.0	09/18/92	JD
IRON	<0.01	09/18/92	MW
MAGNESIUM	3.75	09/18/92	MW
MANGANESE	<0.01	09/18/92	MW
NITRATE as N	0.53	09/15/92	KL
POTASSIUM	4.34	09/18/92	MW
SODIUM	15.3	09/18/92	MW
SULFATE	8.31	09/16/92	KL
SULFIDE	<0.05	09/16/92	KL
pH (SU)	8.00	09/16/92	CI
SUSPENDED SOLIDS	<1.0	09/21/92	JD

COMMENTS: Hydroxide Alkalinity - - -: <1.0 mg/L.

This report for the exclusive use of the client(s) to whom it is addressed. Its disclosure to others for use in advertising is not authorized. These results refer only to the specific sample tested and no interpretation is intended or implied.

Suzanne Howell

Suzanne Howell, Laboratory Manager

ALCHEM LABORATORY

104 West 31st Street
Boise, Idaho 83714
(208) 336-1172

LABORATORY REPORT

PNN

JAMES M. MONTGOMERY, ENGINEERS
161 E. MALLARD
BOISE, IDAHO 83706

ATTENTION: PAT NAYLOR
SOURCE -: MINAM WELL

9/11/92
DATE COLLECTED - - - ~~09/10/92~~
TIME COLLECTED - - -5:25
DATE RECEIVED - - - 09/14/92
DATE REPORTED - - - 09/28/92
SUBMITTED : TERRY SCANLON

LAB SAMPLE NUMBER - 27426

Results reported unless noted: (Chemistry Analysis as mg/l) (Bacteria as organisms/100 ml)

ANALYSIS	RESULTS	DATE ANALYZED	ANALYST
ALKALINITY	77.0	09/25/92	JD
AMMONIA as N	<0.05	09/15/92	CI
BICARBONATE	77.0	09/25/92	JD
CALCIUM	16.0	09/18/92	JD
CARBONATE	<1.0	09/25/92	JD
CHLORIDE	2.80	09/16/92	KL
CONDUCTIVITY (umhos/cm)	174	09/14/92	JD
FLUORIDE	0.33	09/17/92	JD
HARDNESS	53.0	09/18/92	JD
IRON	<0.01	09/18/92	MW
MAGNESIUM	3.75	09/18/92	MW
MANGANESE	<0.01	09/18/92	MW
NITRATE as N	0.53	09/15/92	KL
POTASSIUM	4.27	09/18/92	MW
SODIUM	16.3	09/18/92	MW
SULFATE	8.10	09/16/92	KL
SULFIDE	<0.05	09/16/92	KL
SUSPENDED SOLIDS	<1.0	09/21/92	JD
pH (SU)	8.05	09/15/92	CI

COMMENTS: Hydroxide Alkalinity - - -: <1.0 mg/L.

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Suzanne Howell

Suzanne Howell, Laboratory Manager

ALCHEM LABORATORY

104 West 31st Street
Boise, Idaho 83714
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SEP 21 1992

JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.

LABORATORY REPORT

JAMES M. MONTGOMERY, ENGINEERS
161 E. MALLARD
BOISE, IDAHO 83706

ATTENTION: PAT NAYLOR
SOURCE -: CATHERINE CREEK

DATE COLLECTED - - -09/03/92
TIME COLLECTED - - -8:00
DATE RECEIVED - - - 09/03/92
DATE REPORTED - - - 09/18/92
SUBMITTED : PAT NAYLOR

LAB SAMPLE NUMBER - 27168

Results reported unless noted: (Chemistry Analysis as mg/l) (Bacteria as organisms/100 ml)

ANALYSIS	RESULTS	DATE ANALYZED	ANALYST
ALKALINITY	89.0	09/11/92	JD
AMMONIA as N	<0.05	09/09/92	CI
BICARBONATE	89.0	09/11/92	JD
CALCIUM	18.0	09/18/92	JD
CARBONATE	<1.0	09/11/92	JD
CHLORIDE	0.45	09/17/92	KL
CONDUCTIVITY (umhos/cm)	182	09/14/92	JD
FLUORIDE	0.10	09/08/92	JD
HARDNESS	76.0	09/18/92	JD
IRON	<0.01	09/08/92	MW
MAGNESIUM	7.75	09/18/92	MW
MANGANESE	<0.01	09/08/92	MW
NITRATE as N	0.43	09/10/92	KL
POTASSIUM	2.05	09/18/92	MW
SODIUM	11.8	09/18/92	MW
SULFATE	4.79	09/10/92	KL
SULFIDE	<0.05	09/08/92	KL
SUSPENDED SOLIDS	4.0	09/08/92	JD
pH (SU)	7.70	09/03/92	CI

COMMENTS: Hydroxide Alkalinity - - -: <1.0 mg/L.

Suzanne Howell

Suzanne Howell, Laboratory Manager

ALCHEM LABORATORY

104 West 31st Street
Boise, Idaho 83714
(208) 336-1172

LABORATORY REPORT

PNN
9/2/92

JAMES M. MONTGOMERY, ENGINEERS
161 E. MALLARD
BOISE, IDAHO 83706

ATTENTION: PAT NAYLOR
SOURCE -: CATHERINE CREEK

DATE COLLECTED - - ~~09/03/92~~
TIME COLLECTED - - -1340
DATE RECEIVED - - - 09/03/92
DATE REPORTED - - - 09/18/92
SUBMITTED : PAT NAYLOR

LAB SAMPLE NUMBER - 27169

Results reported unless noted: (Chemistry Analysis as mg/l) (Bacteria as organisms/100 ml)

ANALYSIS	RESULTS	DATE ANALYZED	ANALYST
ALKALINITY	91.0	09/11/92	JD
AMMONIA as N	<0.05	09/09/92	CI
BICARBONATE	91.0	09/11/92	JD
CALCIUM	18.0	09/18/92	JD
CARBONATE	<1.0	09/11/92	JD
CHLORIDE	0.43	09/16/92	KL
CONDUCTIVITY (umhos/cm)	185	09/14/92	JD
FLUORIDE	0.10	09/08/92	JD
HARDNESS	76.0	09/18/92	JD
IRON	<0.01	09/08/92	MW
MAGNESIUM	7.75	09/18/92	MW
MANGANESE	<0.01	09/08/92	MW
NITRATE as N	0.42	09/09/92	KL
POTASSIUM	2.07	09/18/92	MW
SODIUM	12.5	09/18/92	MW
SULFATE	4.84	09/17/92	KL
SULFIDE	<0.05	09/08/92	KL
SUSPENDED SOLIDS	2.0	09/08/92	JD
pH (SU)	7.50	09/03/92	CI

COMMENTS: Hydroxide Alkalinity - - -: <1.0 mg/L.

Suzanne Howell

Suzanne Howell, Laboratory Manager

ALCHEM LABORATORY

104 West 31st Street
Boise, Idaho 83714
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LABORATORY REPORT

JAMES M. MONTGOMERY, ENGINEERS
161 E. MALLARD
BOISE, IDAHO 83706

DATE COLLECTED - - -09/16/92
TIME COLLECTED - - -0800
DATE RECEIVED - - - 09/17/92
DATE REPORTED - - - 09/28/92
SUBMITTED : PAT NAYLOR

ATTENTION: PAT NAYLOR
SOURCE -: IMNAHA WELL

LAB SAMPLE NUMBER - 27603

Results reported unless noted: (Chemistry Analysis as mg/l) (Bacteria as organisms/100 ml)

ANALYSIS	RESULTS	DATE ANALYZED	ANALYST
ALKALINITY	95.0	09/25/92	JD
AMMONIA as N	(0.05	09/22/92	CI
BICARBONATE	95.0	09/25/92	JD
CALCIUM	25.0	09/18/92	JD
CARBONATE	(1.0	09/25/92	JD
CHLORIDE	0.36	09/17/92	KL
CONDUCTIVITY (umhos/cm)	228.0	09/22/92	JD
FLUORIDE	0.18	09/17/92	JD
HARDNESS	78.0	09/18/92	JD
IRON	0.05	09/18/92	MW
MAGNESIUM	4.00	09/18/92	MW
MANGANESE	(0.01	09/18/92	MW
NITRATE as N	0.73	09/17/92	KL
POTASSIUM	1.83	09/18/92	MW
SODIUM	23.3	09/18/92	MW
SULFATE	16.5	09/17/92	KI
SULFIDE	(0.05	09/22/92	KL
SUSPENDED SOLIDS	1.0	09/21/92	JD
pH (SU)	7.55	09/17/92	NH

COMMENTS: Hydroxide Alkalinity - - -: (1.0 mg/l.

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Suzanne Howell

Suzanne Howell, Laboratory Manager

ALCHEM LABORATORY

104 West 31st Street
Boise, Idaho 83714
(208) 336-1172

LABORATORY REPORT

JAMES M. MONTGOMERY, ENGINEERS
161 E. MALLARD
BOISE, IDAHO 83706

ATTENTION: PAT NAYLOR
SOURCE -: IMNAHA WELL

DATE COLLECTED - - -09/16/92
TIME COLLECTED - - -1710
DATE RECEIVED - - - 09/17/92
DATE REPORTED - - - 09/28/92
SUBMITTED : PAT NAYLOR

LAB SAMPLE NUMBER - 27604

Results reported unless noted: (Chemistry Analysis as mg/l) (Bacteria as organisms/100 ml)

ANALYSIS	RESULTS	DATE ANALYZED	ANALYST
ALKALINITY	97.0	09/25/92	JD
AMMONIA as N	<0.05	09/22/92	CI
BICARBONATE	97.0	09/25/92	JD
CALCIUM	25.0	09/18/92	JD
CARBONATE	<1.0	09/25/92	JD
CHLORIDE	0.40	09/17/92	KL
CONDUCTIVITY (umhos/cm)	230.0	09/22/92	JD
FLUORIDE	0.18	09/17/92	JD
HARDNESS	78.0	09/18/92	JD
IRON	0.01	09/18/92	MW
MAGNESIUM	3.75	09/18/92	MW
MANGANESE	<0.01	09/18/92	MW
NITRATE as N	0.74	09/17/92	KL
POTASSIUM	1.85	09/18/92	MW
SODIUM	21.0	09/18/92	MW
SULFATE	16.6	09/17/92	KL
SULFIDE	<0.05	09/22/92	KL
SUSPENDED SOLIDS	<1.0	09/21/92	JD
pH (SU)	7.45	09/17/92	NH

COMMENTS: Hydroxide Alkalinity - - -: <1.0 mg/l.

Suzanne Howell
Suzanne Howell, Laboratory Manager

GEOTECHNIQUES, INC.
2845 SNOWFLAKE DRIVE
BOISE, IDAHO 83706
(208) 336-3795

April 23, 1992

JMM Consulting Engineers, Inc.
161 East Mallard Drive
Boise, Idaho 83706

ATTN: Terry Scanlan
RE: Seismic refraction investigations, Catherine Creek area, near Uni on, Oregon.

During early April, 1992, seismic refraction investigations were undertaken at 2 proposed test-well locations, near Catherine Creek, approximately 10 miles Southeast from Union, Oregon. The study was commissioned to determine the depth to and profile of the alluvium-bedrock contact.

Field data were collected with a 12 channel seismograph utilizing a geophone spacing of 10 meters (32.8 ft). For reference, geophone location 1, in each case, coincides with the test-well location stake. Recordings were made from shots at both end-point geophones (locations 1 and 12). Seismic energy was generated with l/3 pound-equivalent explosive charges.

For purposes of this report, the proposed test well to the Southeast will be defined as site 1 and the proposed test well to the Northwest will be defined as site 2.

SITE 1

The seismic profile at site 1 consists of two spreads referred to as line 1 and line 2. Line 1, geophone 1 coincides with the test well location stake. Line 2, geophone 1 coincides with line 1 geophone 12. Figures 1 and 2 summarize the first arrival times in milliseconds versus the geophone numbers for these two lines. Ref racted arrivals are indicated across most of both liner which allows depth calculations to be made.

Figure 3 is a profile of seismically computed depths to bedrock beneath each of the 23 geophone positions of lines 1 and 2 where stations 1 through 12 are from line 1 and 12 through 23 arm from line 2 (note that station 12 is common to both lines).

A velocity analysis of refracted arrivals from both lines suggest bedrock velocities of 9,000 to 11,000 ft/sec. The depths indicated in the profile (figure 3) are probably conservative. They are based on an assumed average al 1 uvi al fill velocity of 4,000 ft/sec. which may be too low depending on degree of saturation and to some extent the porosity of the fill material. The surf ace layer velocity parameter is the most difficult to determine accurately because it can vary by significant amounts both vertically and laterally. The depths shown in the profile (figure 3) should be viewed as minimums. Bedrock could be as much as 50% deeper.

SITE 2

The seismic profile at site 2 consists of a single spread referred to as line 3. Figure 4 is a summary of arrival times versus qeophone number for this line. Refracted arrivals are observed across most of the spread, allowing seismic depths to be computed. A velocity analysis of these data indicate a bedrock velocity of 10,500 ft/sec. Calculated depths are summarized in profile (figure 5) for this line. Again, as discussed for site 1, the depths-shown should be considered minimums.

Paul R Donaldson
4-27-92

Paul R Donaldson, PhD
Registered Professional Geologist/Geophysicist

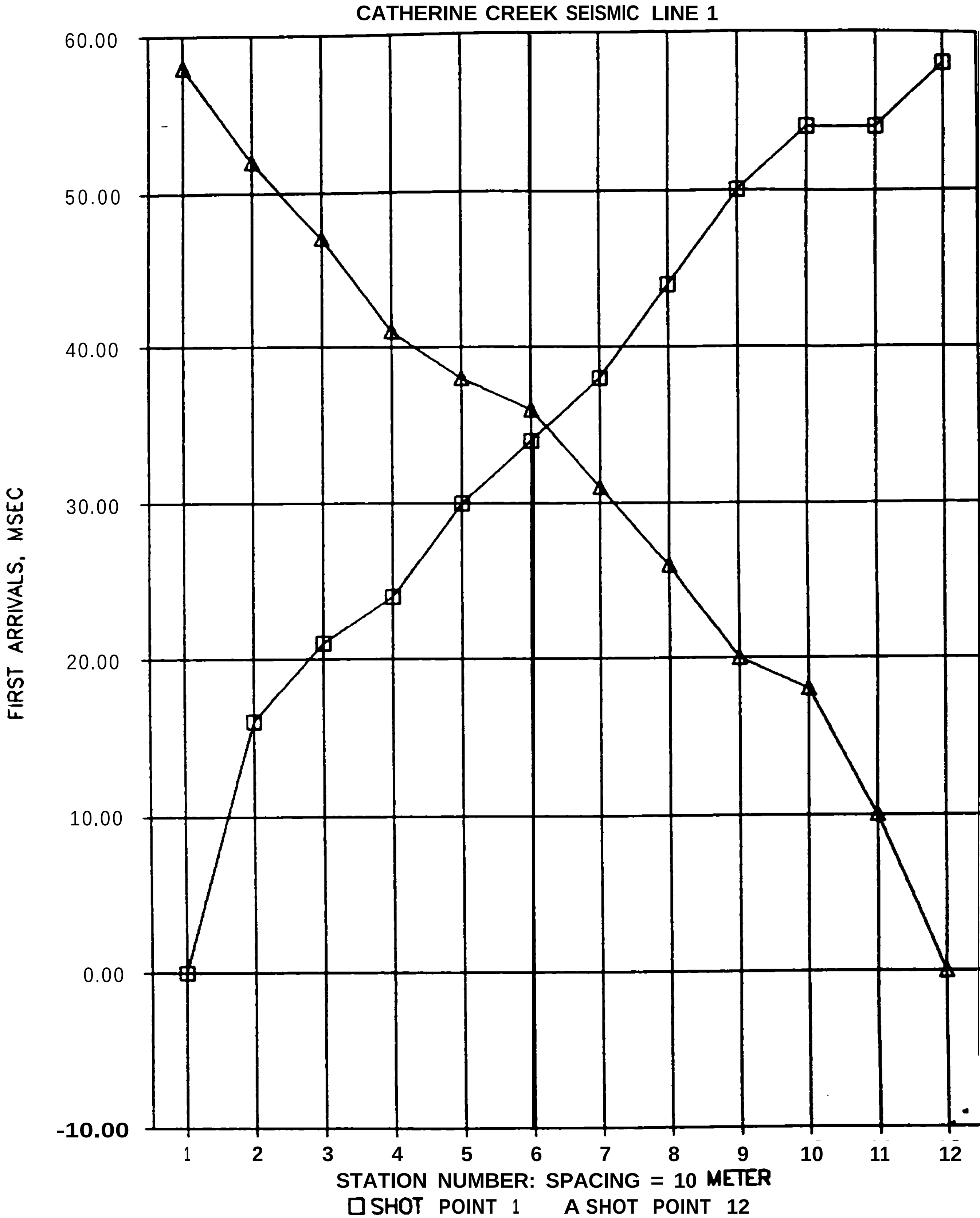

CATHERINE CREEK SEISMIC LINE 1
60.00
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
FIRST ARRIVALS, MSEC
1
2
3
4
5
6
7
8
9
10
11
12
STATION NUMBER: SPACING = 10 METER
☐ SHOT POINT 1 A SHOT POINT 12

Figure 1

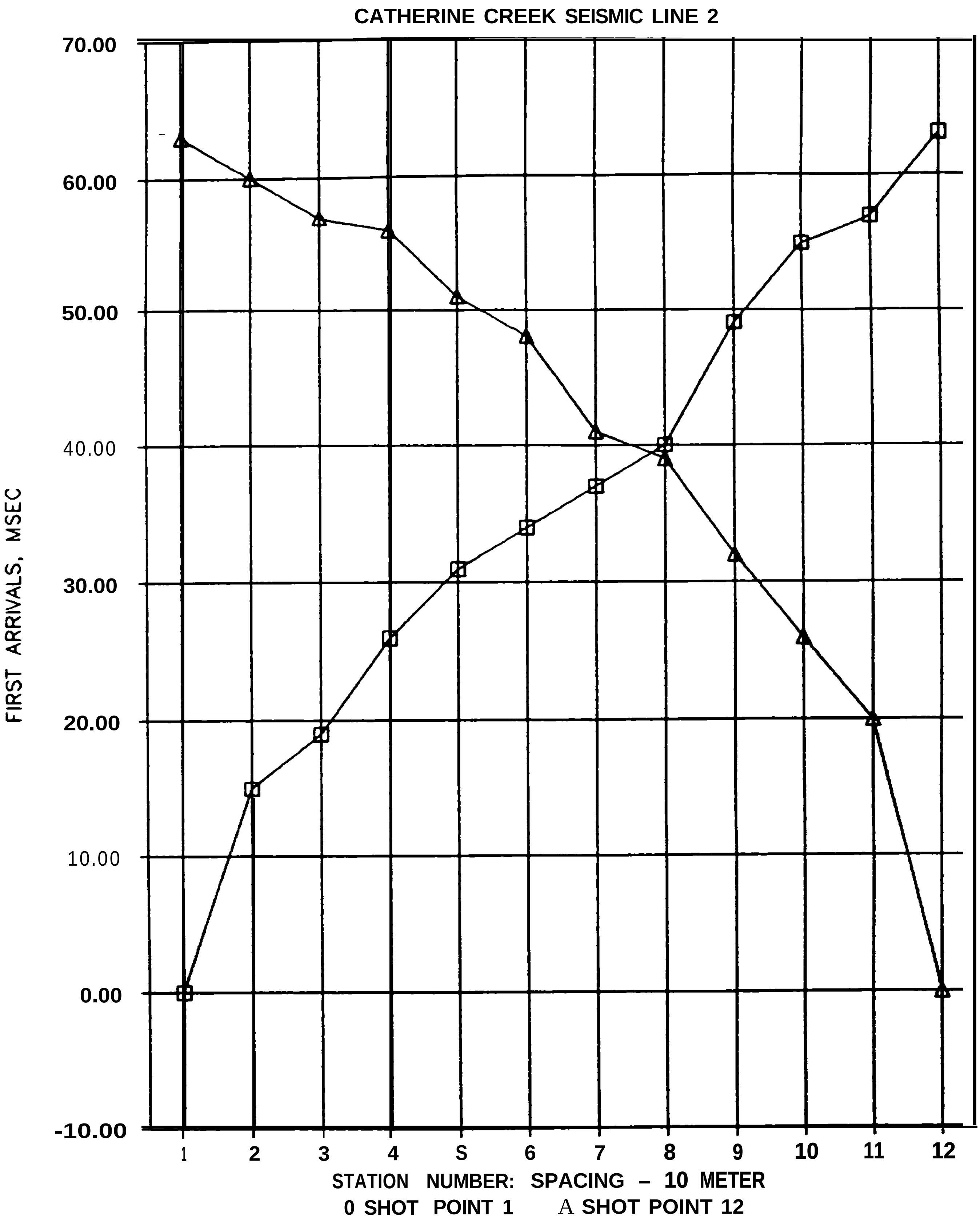
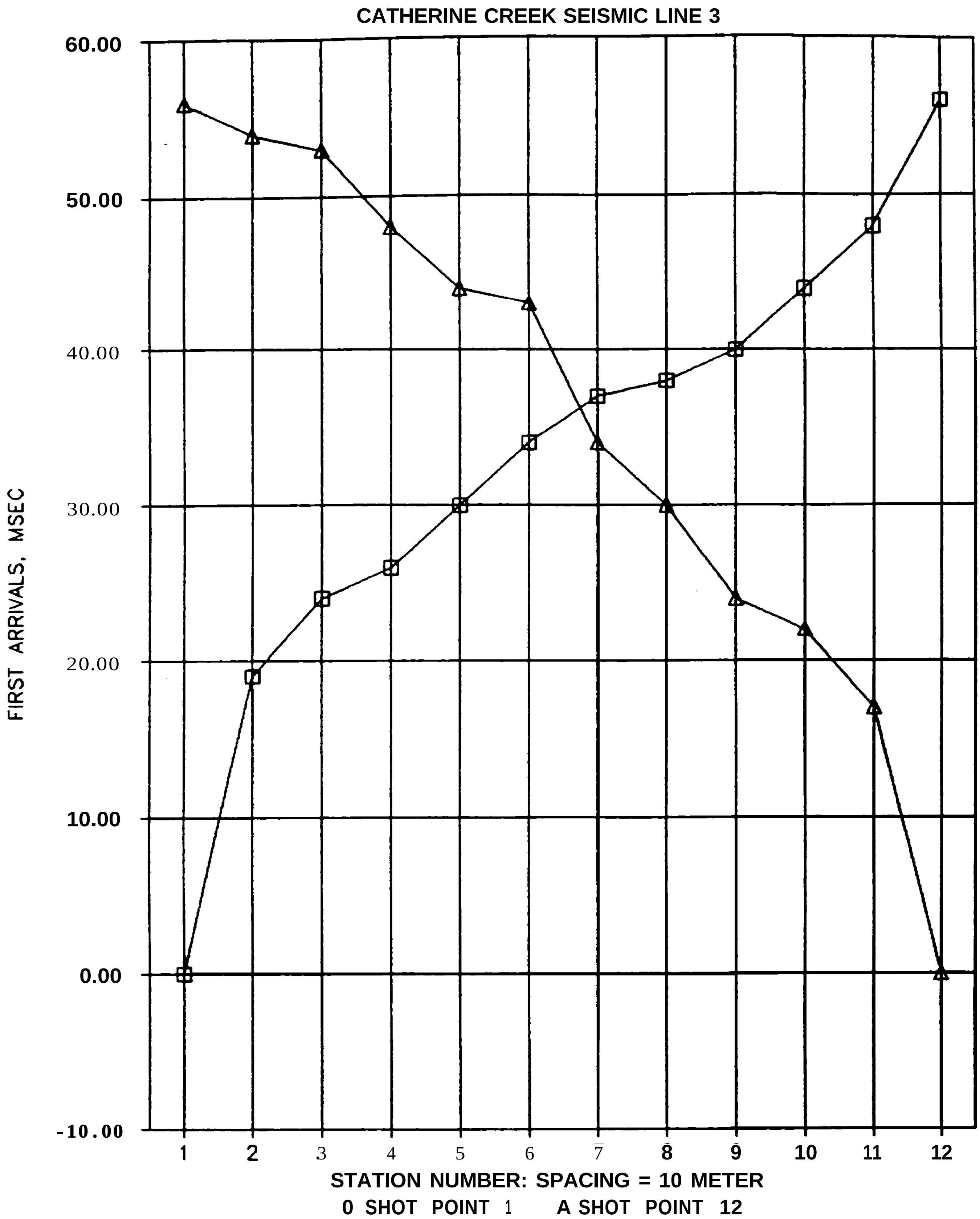

CATHERINE CREEK SEISMIC LINE 2
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
FIRST ARRIVALS, MSEC
1
2
3
4
S
6
7
8
9
10
11
12
STATION NUMBER: SPACING – 10 METER
0 SHOT POINT 1 A SHOT POINT 12

Figure 2



CATHERINE CREEK SEISMIC LINE 3
60.00
50.00
40.00
30.00
20.00
10.00
0.00
-10.00
FIRST ARRIVALS, MSEC
1
2
3
4
5
6
7
8
9
10
11
12
STATION NUMBER: SPACING = 10 METER
0 SHOT POINT 1 A SHOT POINT 12

Figure 4

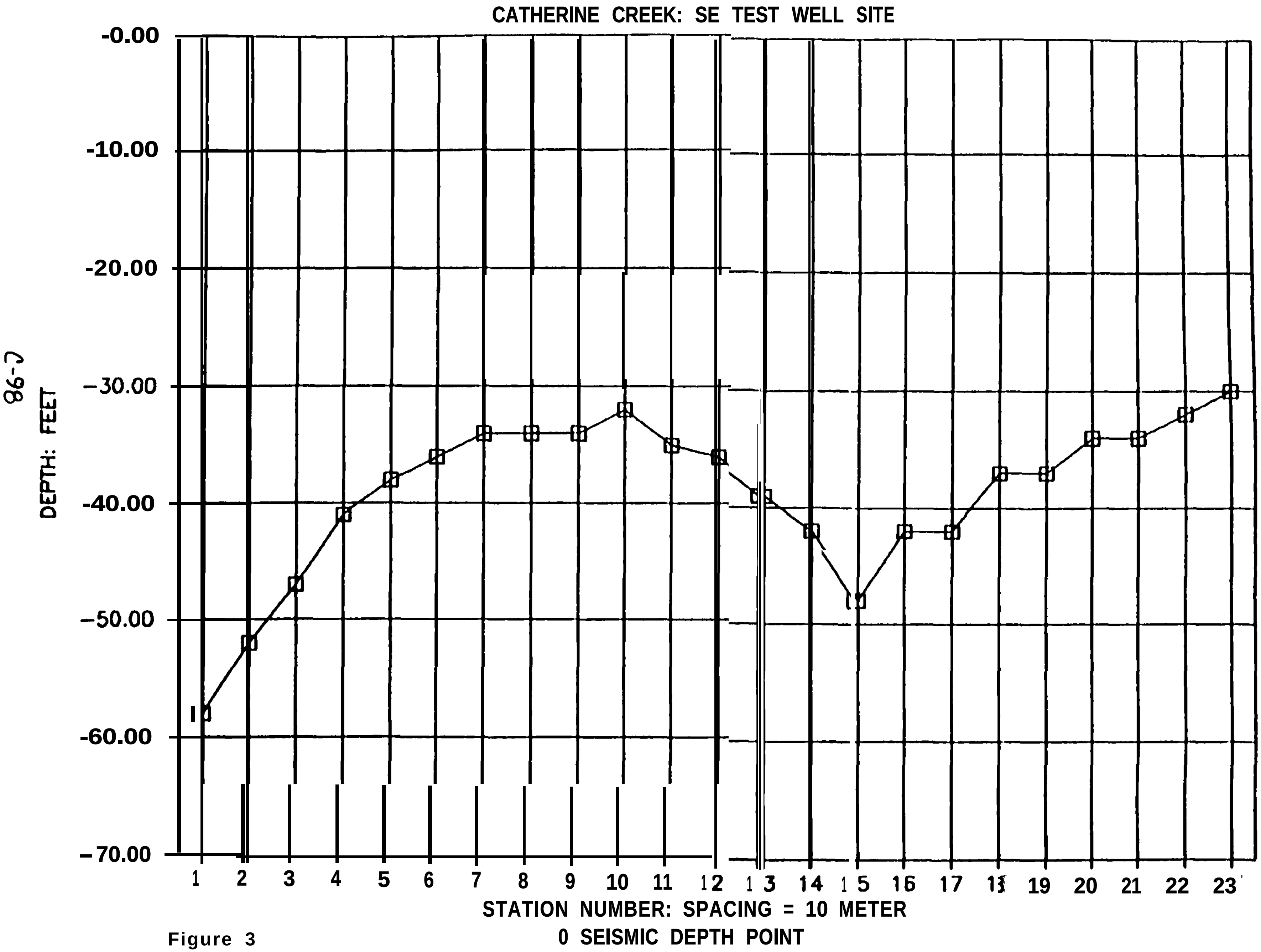
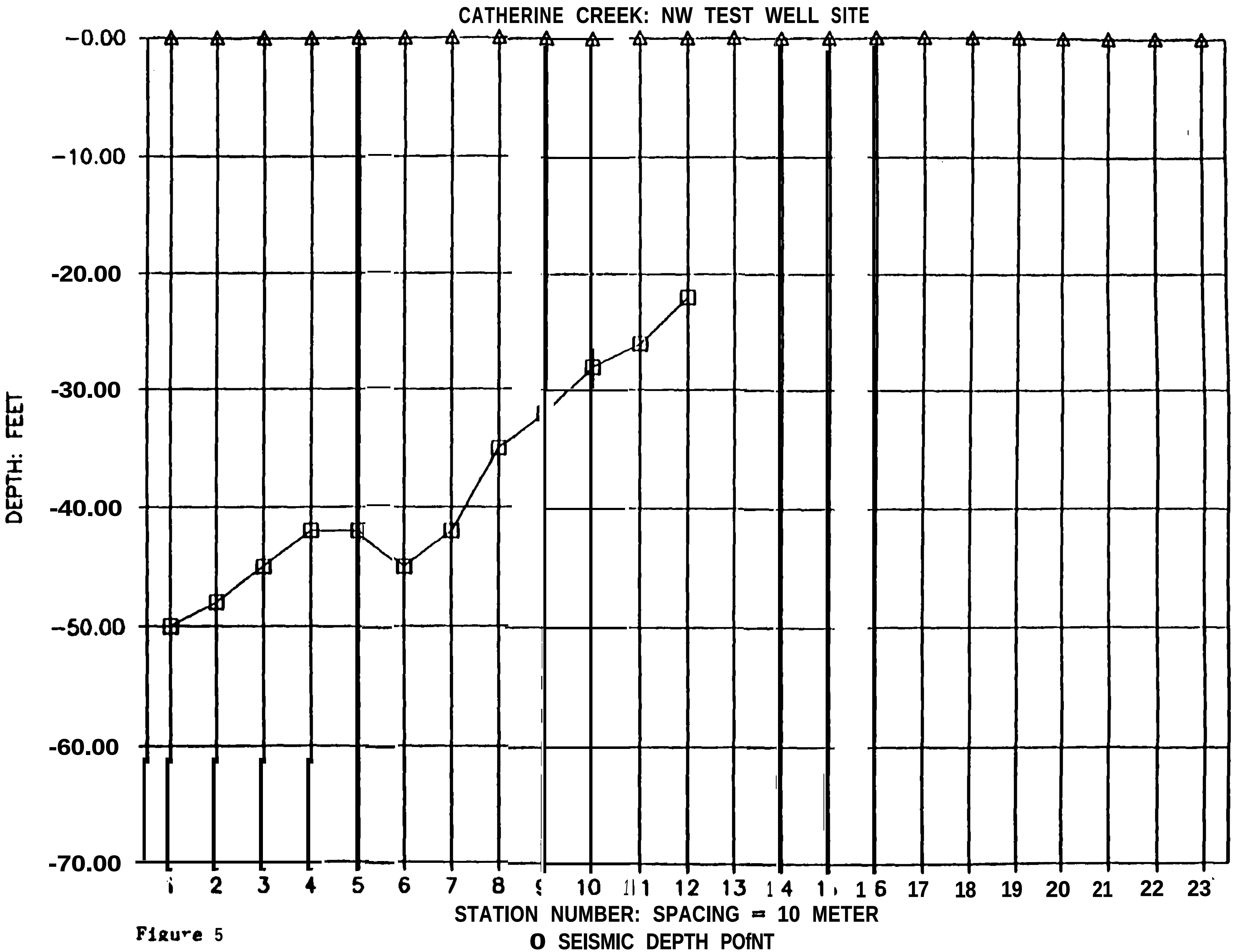

CATHERINE CREEK: SE TEST WELL SITE
DEPTH: FEET
-0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
STATION NUMBER: SPACING = 10 METER
0 SEISMIC DEPTH POINT
86-7

Figure 3


CATHERINE CREEK: NW TEST WELL SITE
-0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
DEPTH: FEET
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
STATION NUMBER: SPACING = 10 METER
O SEISMIC DEPTH POfNT

66-J

Figure 5